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# POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

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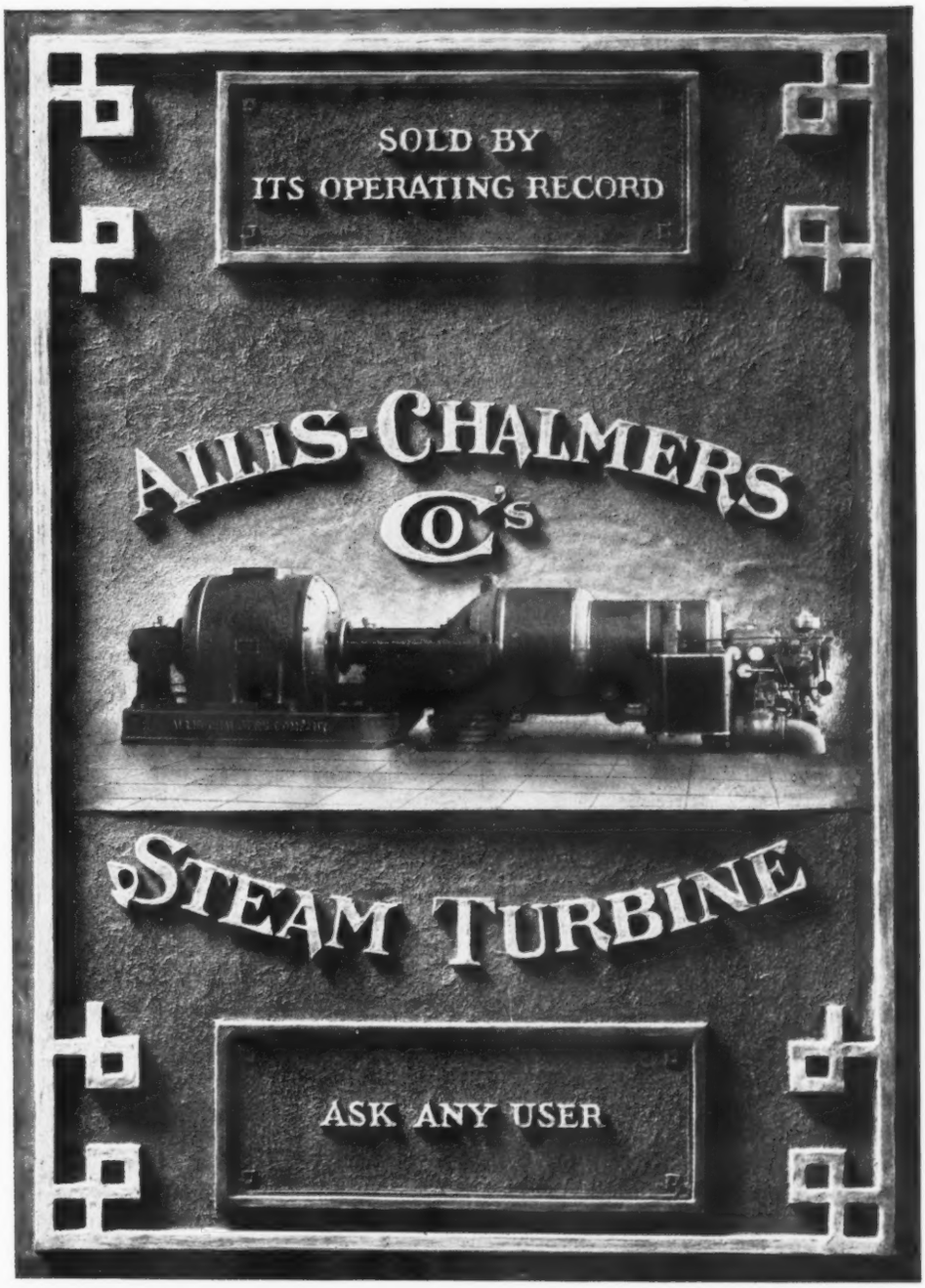


# Don't Let Scale Get The Start Of You

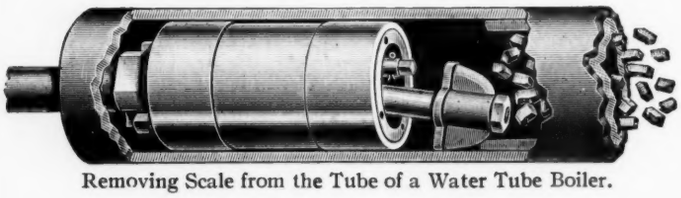
If you had an engineer who was carrying out into the ash pile 15 to 25 per cent. of his coal unburned, what would happen to the poor man?

What's the difference if it goes up the chimney?

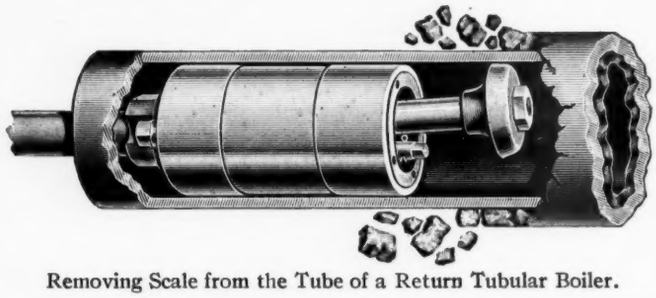
That's just what you are doing with it as long as there is scale on your boiler tubes.

The worst of it is, you may be in blissful ignorance that you have scale.

Scale is an insidious agent. It does its work in the dark. By the time it betrays its presence it has wrought great waste in your plant.



Removing Scale from the Tube of a Water Tube Boiler.



Removing Scale from the Tube of a Return Tubular Boiler.

## THE DEAN BOILER TUBE CLEANER

To find scale, use the DEAN; to remove scale, use the DEAN; to keep the boiler scale-free, keep using the Dean.

The DEAN BOILER TUBE CLEANER is cheaper than compounds and is a hundred per cent. more efficient; it costs no more than other cleaners and is 200 per cent. more durable.

You can measure the efficiency of your present methods of fighting scale by the use of the DEAN. Suppose you try it. You won't lose any money by making the trial. You may make lots of it, by the discovery that you've been making a mistake all these years.

Shall we loan you a DEAN, free of charge, for trial in one boiler?

*Want a copy of "From Water To Steam," as a starter?*

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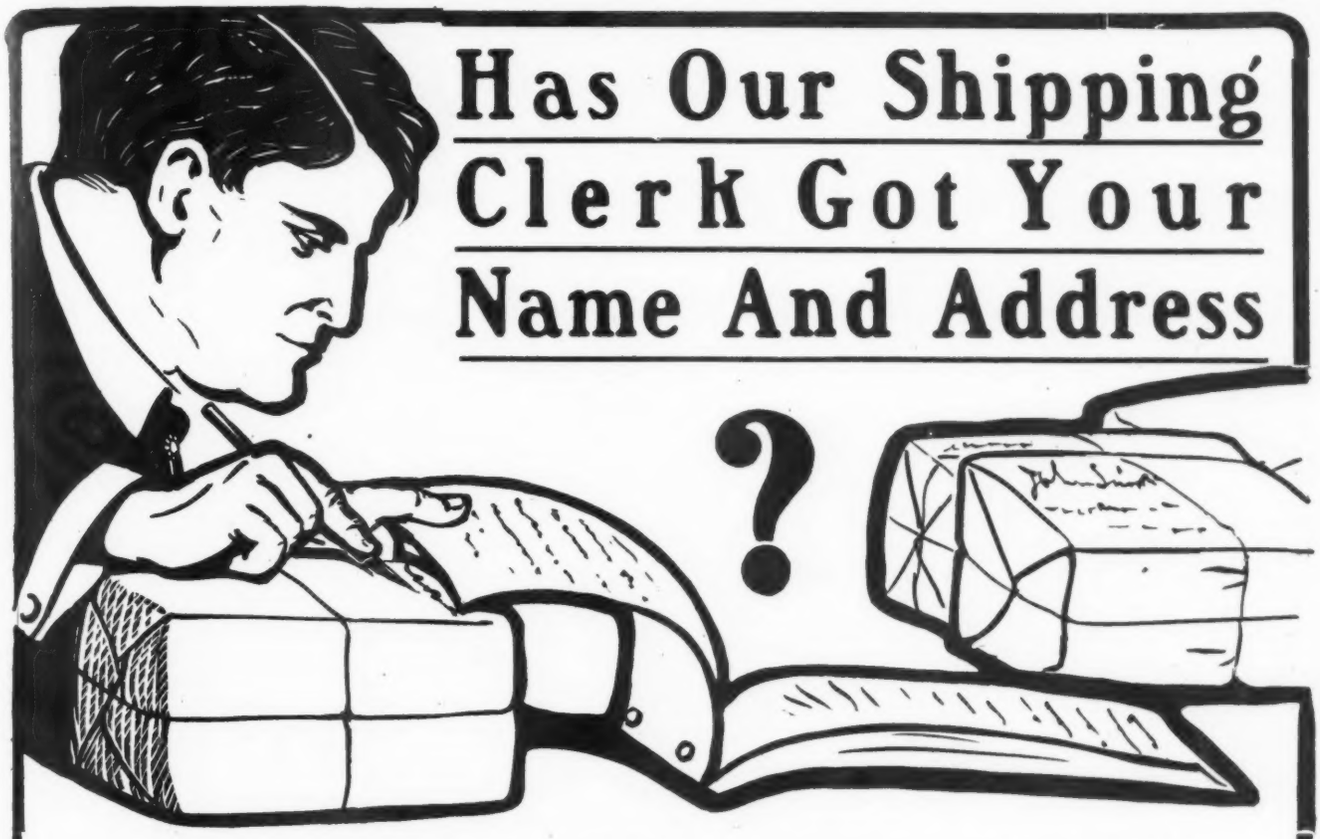

# Has Our Shipping Clerk Got Your Name And Address ?

If not, mail us the attached coupon and he'll send you, express prepaid, and absolutely

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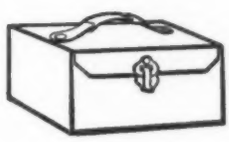
A Large Can of Keystone Grease



An Engineer's Collapsible Lunch Box

All we ask in return is a fair trial, on your engines, of

## KEYSTONE GREASE

Wherever Keystone Grease is used it's known as the "World's Greatest Lubricant." It outlasts all others many times over and is friction's arch-enemy. Write today.

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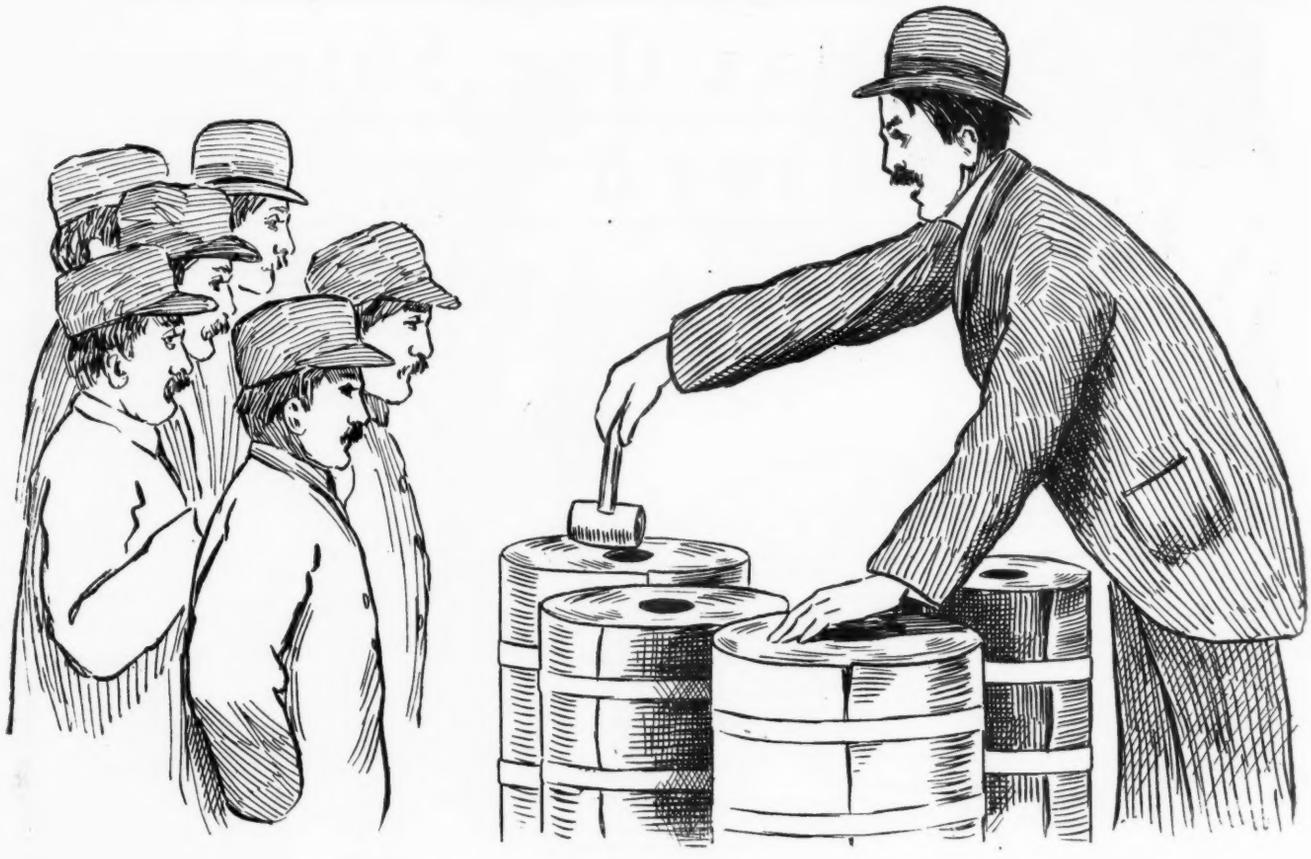
Name.....
Name of Firm.....
.....
Address in Full.....
.....
.....
H. P. of Engine.....
On what bearing will sample be tested?
.....
Its width.....
R.P.M.....
Size of tap for cup.....
July 21-08, Dept. B.



Auctioneer: "Now, gentlemen, I am going to dispose of the entire stock of the Old Fogy Packing Supply Co. What am I offered for this roll of Antiquate sheet packing? Something fine, I guess. Sure to give satisfaction. What am I offered a pound? One dollar? Seventy-five cents? Come boys, don't let this chance slip by. What will you start it at? Twenty-five cents? No bid? All right, pass it along.

Now, gentlemen, step up closer, please. I am going to offer you something special—something you want. This celebrated Before-The-Flood packing. There's quality in every inch, gentlemen, in every inch! Now, what am I offered a pound? Ten cents? What? Ha! Ha! Well, let her start at that. Now, boys, ten cents, ten cents. Who'll make it fifteen? Come boys, I can't make a sale on one bid. Who'll make it fifteen? No offer? Then we'll have to pass it up.

I guess, boys, you're out for something choice. Well, here it is, the choicest ever! A black sheet packing that's a Cracker-Jack. What's that? Is it Ebonite? Well, no, but I guess it's just as good." (Chorus of voices) "There is no packing that's just as good as EBONITE Black Sheet Packing. We know! We've tried Daniel's EBONITE for superheated steam, high steam pressures, hot and cold water, oil, ammonia, gas, and everywhere you can use a packing, and there isn't anything that can touch EBONITE."

## OUR SPECIAL EBONITE OFFER

Send us a description of the worst joint in your entire plant and we will send you some EBONITE to pack it. If after a fair trial it fails to prove better than any packing you have ever used we will refund you your money.

SEND FOR BOOKLET, TOO.

# QUAKER CITY RUBBER CO.

**PHILADELPHIA** **CHICAGO** **PITTSBURGH**

VOLUMES have been written authoritatively on the excess cost of producing a given horse-power in boilers that are coated with incrustation. Scale one-thirty-second to one-sixteenth inch thick increases the fuel consumption ten to fifteen per cent., and greater scale thickness means greater loss of heat.

In these times of keen competition, when the greatest manufacturing economy must be exercised, the Engineer, Superintendent, Manager, Owner, are vitally interested in reducing these unnecessary operating expenses.

That the boiler water troubles are being successfully handled by the Dearborn Company, in 11,000 steam plants, keeping boilers clean, and preventing waters from pitting boilers and tubes, the work being done under a combination scientific laboratory and practical engineering guidance, should appeal to the discriminating operator desiring to better results.

Gallon samples of waters required for analysis, after which we will tell you how to remedy the troubles you experience, and the cost to do it right.

**DEARBORN DRUG & CHEMICAL WORKS**

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Honolulu, 42 Queen Street
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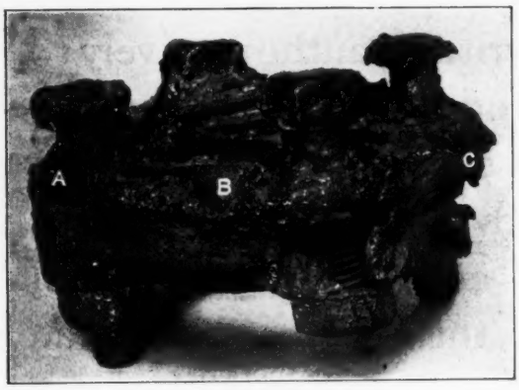
Indianapolis
Peoria, Mayer Building




IN every power plant there are leaks in pipe lines, cracks in tanks, pumps, etc., that can be easily and permanently repaired with **Smooth-On** iron cement.

Not only are cracks in steam and water piping easily repaired but boiler cracks are just as easily taken care of, and cracks that are right in the fire box exposed to the hottest flames.

Many engineers say "Of course Smooth-On is all right for some purposes but can it stand direct furnace heat?"

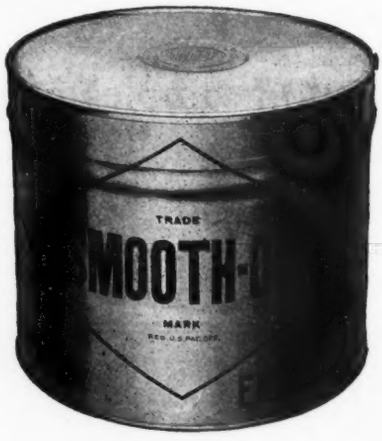
We have repaired boilers, kettles, etc., with our **Smooth-On Iron Cement No. 1** that have to stand the direct flame and in every case the repair has been permanent.

The Illustration at the top of this page will give an idea of how well **Smooth-On Iron Cement No. 1** can withstand intense heat. It shows a pipe flange which was bolted together, the pipe line during a fire dropped in a bed of hot coals, the lower flange was entirely melted away, the **Smooth-On** with which the joint was packed is shown along the line **A B C** and protected the upper flange so that it was practically undamaged except on one edge. (In the picture the undamaged flange is shown underneath.)

This test easily proves the value of **Smooth-On Iron Cement No. 1** for boiler repairs.

Remember we make **Smooth-On** for various places and for various uses. It is the engineers greatest help on account of its adaptability to suit various conditions.

We would be pleased to send a free copy of the **Smooth-On Instruction Book** to any engineer upon application.




# SMOOTH-ON MANUFACTURING COMPANY

## JERSEY CITY, N. J., U. S. A.

**Chicago Warehouse**
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**San Francisco Warehouse**
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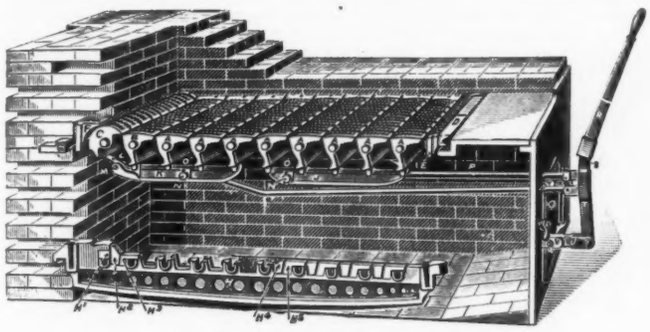
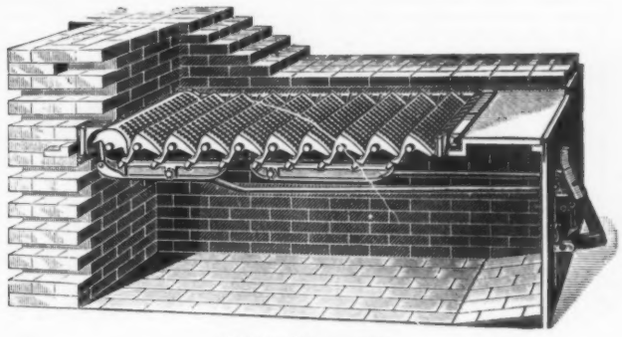


Normal Position of Grate



Shaking Movement


# CANDIDATES FOR THE OFFICE OF FUEL SAVERS

**McCLAVE GRATES**

Argand Steam Blower

**ARGAND BLOWERS**

On the fuel-cost-reduction platform.

They guarantee that throughout their long term of office they will burn every ounce of fuel to best advantage and that without any loss of efficiency; they will use only the cheap grades of fuel such as anthracite, birdseye, rice, etc.

Send today for their campaign literature, read it carefully and you will surely vote their straight ticket.

## McCLAVE-BROOKS COMPANY
### SCRANTON, PA.

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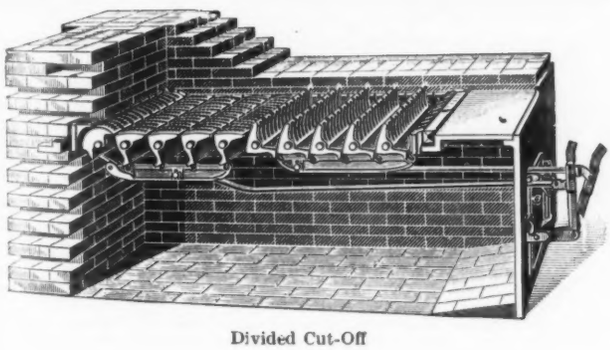
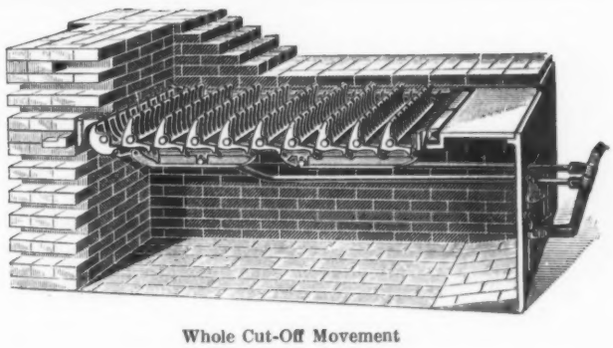


Divided Cut-Off



Whole Cut-Off Movement

# REASONS WHY

THE TRADE PENBERTHY MARK.

(Reg. U. S. Pat. off.)

## AUTOMATIC INJECTOR

### Always "Makes Good"

1st—It will work on higher pressure and handle hotter water.

2nd—It will lift further vertically on a greater range of pressure.

3rd—It delivers a maximum amount of water with a minimum amount of steam.

**Try the PENBERTHY it never fails.**

TRADE PENBERTHY MARK. **"XL-96"**

## EJECTOR OR SYPHON

Has no equal in lifting or elevating liquids. Used Exclusively by the leading creameries, tanneries, breweries, brickyards, distilleries and dye houses in the country.

## SPECIAL "XL-96" NON-ELEVATING EJECTOR

Heats liquids to a minimum; Lifts 28 feet; Uses less steam and delivers 33⅓% more liquid than any Ejector made. A trial will convince you.

**CIRCULAR ON REQUEST.**

*The new "Engineer & Fireman" (80 page magazine) will be sent to any engineer who will send his name and address.*

# PENBERTHY INJECTOR CO.,

**Largest Manufacturers of Injectors in the World**

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Garlock High Pressure Ring Style No. 200 for High Pressure Steam Service is generally accepted as Reliable and Satisfactory.

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## THE GARLOCK PACKING COMPANY

**Main Offices and Factory, PALMYRA, N. Y.**

**24 Branch Offices and Stores** **5 Branch Factories**

**Represented in all of the principal cities**

# BURT
## Ventilators

The cut shows the plant of The Yale & Towne Mfg. Co., one of the largest and most prominent concerns in the U. S. equipped with our Ventilators and we quote herewith their recent letter concerning same:

THE YALE & TOWNE MFG. CO., Stamford, Conn., Feb. 18th, 1908.

The Burt Manufacturing Co., Akron, O.

Gentlemen—Acknowledging receipt of your letter of Feb. 15th, we have to advise that the ventilators placed on the saw-teeth of a recent addition to our buildings have given excellent satisfaction. We are pleased with the principle of design, in fact, at the time of the building, we had begun the design of a regulating ventilator for our own use which would combine the advantages of the cowel and of the ventilator without the disadvantages of the sticking of the one and the interfering currents produced by the damper of the other, when our investigation brought the Burt Ventilator to our attention. We ordered twenty eighteen-inch ventilators. Very truly yours,

THE YALE & TOWNE MFG. CO. By H. J. Lamborn, Supt. Power and Plant.

*SEND FOR OUR 92-PAGE CATALOG.*

**THE BURT MFG. CO., 232 Main St., Akron, O., U.S.A.**

**Largest Manufacturers of Oil Filters in the World.**

**George W. Reed & Co., Montreal, Sole Manufacturers of "Burt" Ventilators for Canada**

## Operated by Centrifugal Force the "Standard" Exhaust Head

makes a perfect separation of oil and water from exhaust steam. They keep your roofs and walls clean and dry.

Illustration shows a 30-inch "Standard" made out of No. 10 gauge iron, furnished the Jones & Laughlin Steel Co., Pittsburg.

*SEND FOR OUR 02-PAGE CATALOG.*

**THE BURT MFG. CO., 232 Main St., Akron, O., U.S.A.**

# Equipment of a Modern Central Station

## Description of the Apparatus and Operating Features of the Steam-Hydro-electric Plant of the People's Power Company, Moline, Illinois

BY OSBORNE MONNETT

Located in the midst of a populous center, the power plant of the People's Power Company, Moline, Ill., has grown from the simplest beginning, through all the stages of lighting and power development, until it has now reached a point where it can be classed as a modern central station, carrying the greatest part of the entire power and lighting load of three cities: Davenport, Rock Island and Moline.

Natural advantages originally determined the location of the plant at the foot of Fourth street, Moline, on the bank of the Mississippi river, at a narrow passage between the main land and Sylvan island, where a water power has been developed giving an average head of 8 feet the year round. This water power has always operated in conjunction with the steam plant, which formerly consisted of Cahall vertical water-tube boilers, hand-fired, furnishing steam to three horizontal cross-compound Buckeye engines, running with belted jet condensers and connected by rope drive to a line shaft running the entire length of the station. The water power was at this time utilized by means of a rope drive extending over a bridge some 250 feet in length from Sylvan island, as indicated by the dotted lines in Fig. 3. With the improvement of electrical machinery, belted units were gradually discarded until only one of the old engines remains, this being held as a reserve unit.

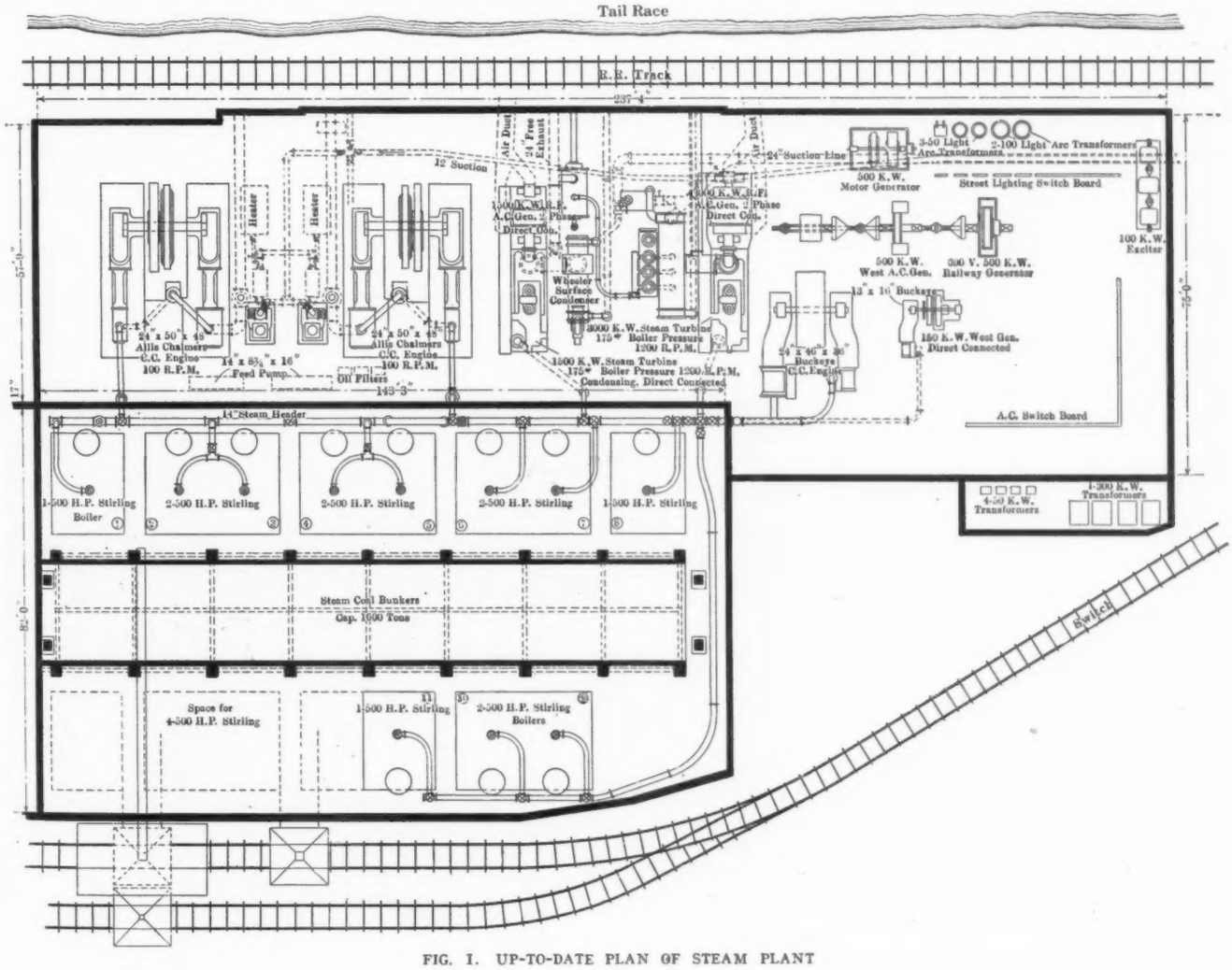
Tail Race
R.R. Track
237'-4"
12" Suction
Air Dust
24" Free Exhaust
Heater
1500 K.W. R.P. A.C. Gen. 2 Phase Direct Con.
Wheeler Surface Condenser
3000 K.W. Steam Turbine 175# Boiler Pressure 1200 R.P.M.
1500 K.W. Steam Turbine 175# Boiler Pressure 1200 R.P.M. Condensing. Direct Connected
24" Suction Line
3-50 Light Arc Transformers
2-100 Light Arc Transformers
500 K.W. Motor Generator
Street Lighting Switch Board
100 K.W. Exciter
500 K.W. West A.C. Gen.
300 V. 500 K.W. Railway Generator
13" x 16" Buckeye
150 K.W. West Gen. Direct Connected
24" x 46" x 36" Buckeye C.C. Engine
A.C. Switch Board
24" x 50" x 48" Allis Chalmers C.C. Engine 100 R.P.M.
14" x 8½" x 16" Feed Pump
Oil Filters
24" x 50" x 48" Allis Chalmers C.C. Engine 100 R.P.M.
145'-3"
14" Steam Header
1-500 H.P. Stirling Boiler
2-500 H.P. Stirling
2-500 H.P. Stirling
2-500 H.P. Stirling
1-500 H.P. Stirling
1-300 K.W. Transformers
4-50 K.W. Transformers
Steam Coal Bunkers Cap. 1500 Tons
Space for 4-500 H.P. Stirling
1-500 H.P. Stirling
2-500 H.P. Stirling Boilers
Switch
57'-0"
82'-0"

FIG. 1. UP-TO-DATE PLAN OF STEAM PLANT

### Boiler Room

As finally completed the steam-driven station, a plan view of which is shown in Fig. 1, consists of a boiler room, 143x82 feet, designed for two rows of boilers with an ultimate capacity of 9000 boiler-horse-power. At the present writing eleven 500-horse-power Stirling water-tube boilers, each with 252 three-inch tubes, carrying 200 pounds gage pressure and operating with saturated steam, are installed. The boilers are fitted with Atwood non-return stop-valves, Williams water columns and feed controls and

Homestead straight-way blow-off valves, the blow-offs being piped direct to the river and protected by Pittsburg gate valves placed on the boiler side. Five of the boilers are fitted with Roney stokers, which are driven by a line shaft and Westinghouse engine in the usual manner. The remainder of the boilers have on either branch of the loop. Two main feed-pumps are located in the basement of the engine room. These are of Epping-Carpenter outside-packed, pot-valve plunger make, 14x8¾x16 inches, and take water from three 3000-horse-power Cochrane open heaters. The heaters act as receivers for the discharge from the hot-

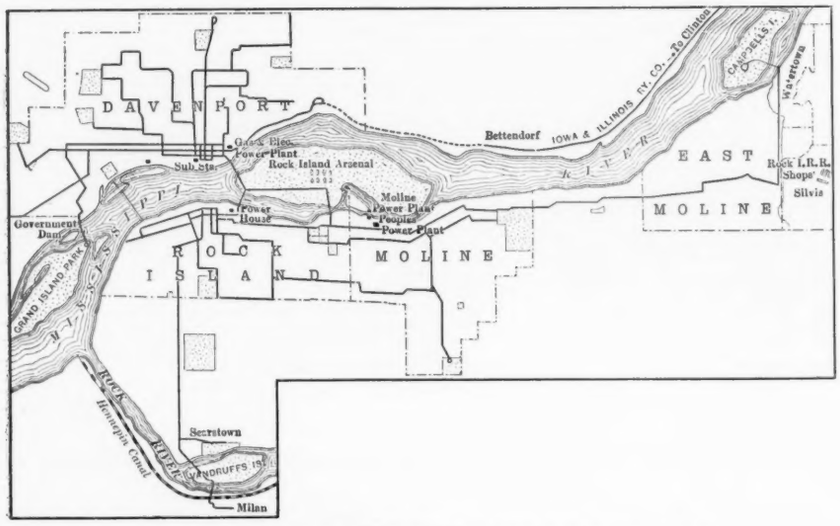


FIG. 2. LOCATION OF POWER HOUSES AND RAILWAY SYSTEM

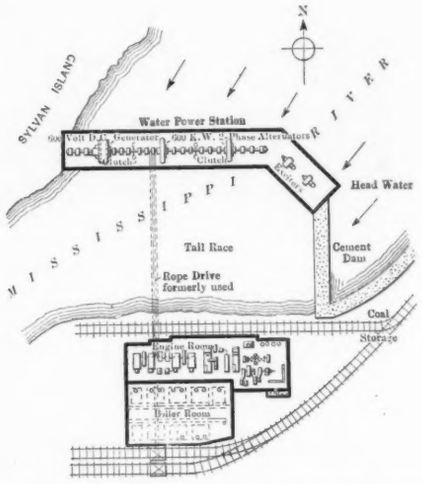


FIG. 3. RELATIVE POSITIONS OF STEAM AND WATER-POWER STATIONS

Green traveling link grates, 11 feet wide by 10 feet long, and fitted with adjustable water-backs. Fig. 4 is a view of the boiler room.

### Coaling System

Coal is dumped from cars into one of three hoppers located outside of the boiler house, two of these hoppers being used for screenings, which is the fuel usually burned. In this case it is carried direct, by means of Hunt belt conveyers, to elevating bucket conveyers, two of which are installed, one of Jeffrey make and one Hunt. Lump coal utilizes the third unloading hopper which is provided with a Jeffrey crusher delivering coal to the belt conveyer. All conveyers are driven by Westinghouse 440-volt, two-phase induction motors. A coal-storage capacity of 2000 tons is provided in the bunkers, and an outside storage yard with a capacity of 3000 tons can be utilized in an emergency.

Ashes are shoveled from the stoker-pits into the bucket conveyers, to be elevated to a belt conveyer, which delivers them into a hopper over the tracks. From the hopper they may be loaded in cars or wagons as convenience dictates.

### Boiler Feed-water

Exceptionally complete arrangements are provided for feeding the boilers and every precaution has been taken to guard against interruption of the supply. The feed piping is arranged on the loop system, extending behind the boilers with a tap to each boiler from each side of the loop, and liberally cross-valved so that feed may be taken from either direction wells of the turbines and receive the exhaust from all the steam-driven auxiliaries, the make-up water being taken from the overflow of the jet condensers, or, in case the latter are not running, from the cold-water supply of the station, which is maintained by a Deane of Holyoke 10x16x12-inch pump controlled by a Williams governor at a pressure of 150 pounds per square inch. Feed is taken from the heaters at an average temperature of 210 degrees Fahrenheit, and as the drop from the heaters to the feed-pumps is small, the springs on the suction valves are made extremely light in order that the pumps may receive a full supply of water at each stroke. Two Deane of Holyoke outside end-packed plunger pumps, 10x10x12 inches, are used as reserve units. All of these pumps are fitted with Williams governor valves, set at 250 pounds, as part of the feed-regulating system.

### Piping

Fittings and valves on the steam lines are of Crane and Pittsburg Valve and Foundry Companies' makes and joints are packed with asbestos tape. Two 4½-inch Crane pop valves are fitted to each boiler. The main header is 14 inches in diameter and is drained by Williams steam-actuated traps. Each boiler has an individual self-supporting steel stack 5 feet in diam-

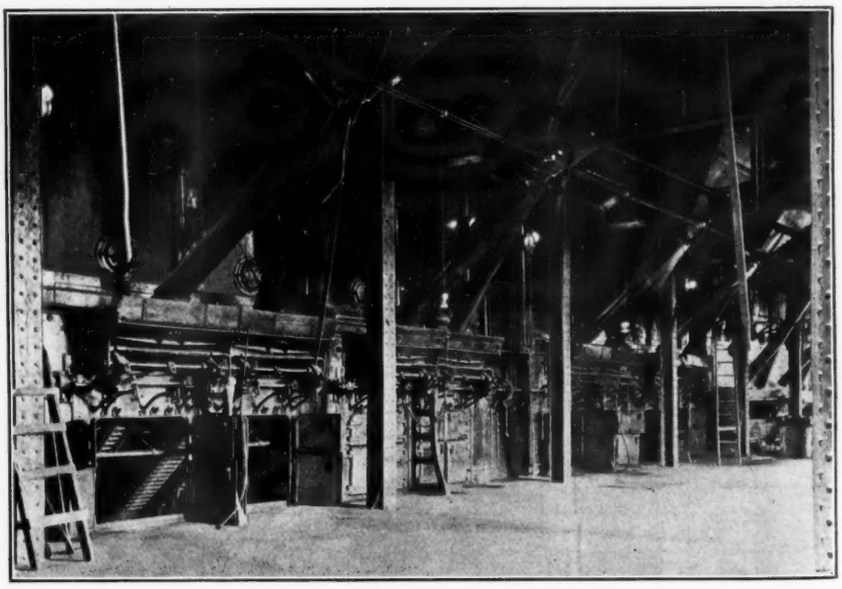

FIG. 4. BOILER FRONTS AND COAL HOPPERS

eter and 125 feet high from the top of the boilers, and the average draft obtained is one inch of water.

### Engine Room

In this department, a general view of which is shown in Fig. 5, are located two Allis-Chalmers horizontal cross-compound condensing engine units, each driving a 1000-kilowatt, 4800-volt, two-phase, 60-cycle Westinghouse revolving-field alternator. These engines take steam from 10-inch branch lines, fitted with wrought-steel separators, and drained by Williams traps. The engines have automatic stop-valves for emergency use. The governor controls the cut-off from nothing to three-quarters stroke, and the low-pressure cut-off may be independently adjusted by hand as well as controlled by the governor. The engines run at 100 revolutions per minute, have cylinders 24 and 50 inches in diameter by 48-inch stroke, and exhaust into Dean of Indianapolis vertical double-acting jet condensers, taking injection water from above the dam. The vacuum maintained is high, averaging 27 inches of mercury.

Fig. 6 shows the location of one of these jet condensers, the low-pressure cylinder of one of the engine units and the steam-actuated traps which drain the main header. An oiling system is provided for the two steam units, consisting of an elevated tank in the boiler room, from which the oil flows by gravity to the engines. Nugent oiling devices are used, and the oil is collected and filtered in White Star sectional filters. It is elevated by Worthington pumps to the supply tank.

### Turbine Units

Increasing load required the installation of a 1500-kilowatt Westinghouse turbine, driving a 4800-volt, two-phase generator and exhausting into a C. H. Wheeler surface condenser served with Wheeler auxiliary apparatus throughout. This unit is of standard Westinghouse construction and is capable of standing heavy overloads. The auxiliary machinery for this unit and a 3000-kilowatt turbine, recently installed, are located in a well between the two units. Water circulation for the smaller condenser is effected by an 8x9-inch vertical engine, driving a centrifugal pump with an 8-inch discharge. A vacuum within 2 inches of absolute is maintained at all times by an 8x18x12-inch Mullan double-acting, valveless-suction air pump, driven by steam.

The larger turbine unit has a surface condenser containing 10,000 square feet of cooling surface, as compared to 4000 square feet for the smaller turbine. Fig. 7 shows a view of the generator end of the 3000-kilowatt unit, giving a good idea of the inclosed construction. The circulating unit consists of a 12x14-inch vertical engine, driving an 18-inch centrifugal pump; the air pump is a geared, steam-driven, triplex Mullan pump, with valveless suction and single-acting. It is shown in Fig. 8, and maintains a high vacuum without the aid of a dry-vacuum pump.

A peculiar feature of this condensing apparatus is that owing to the elevation of the water supply above the dam, it is necessary to use the circulating pumps only in starting the condensers. After a circulation has been established, a valve passing from the injection main is opened and the circulating pumps may be shut down, the condensers receiving their water through a siphoning action and discharging into the tail-race alongside the station. This makes the apparatus extremely economical of steam, and is a combination which can only be taken advantage of in special instances. Fig. 9 shows a diagram of the connections for accomplishing this interesting result.

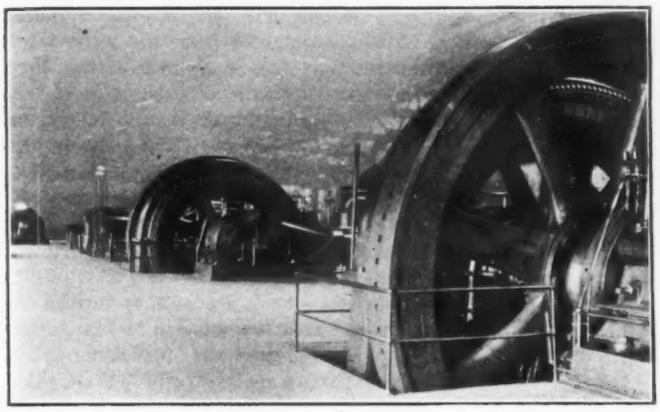

FIG. 5. GENERAL VIEW OF ENGINE ROOM

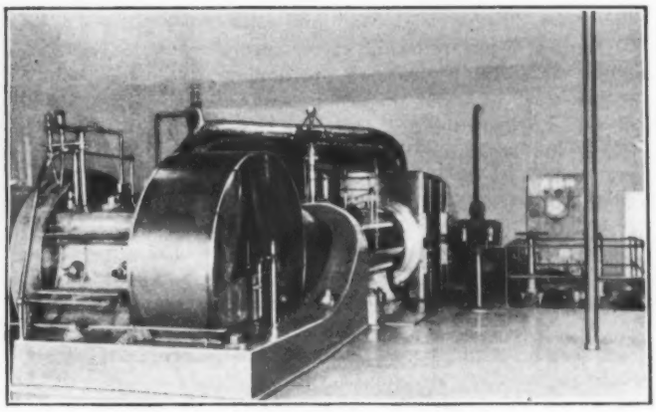

FIG. 6. LOW-PRESSURE SIDE OF ENGINE UNIT

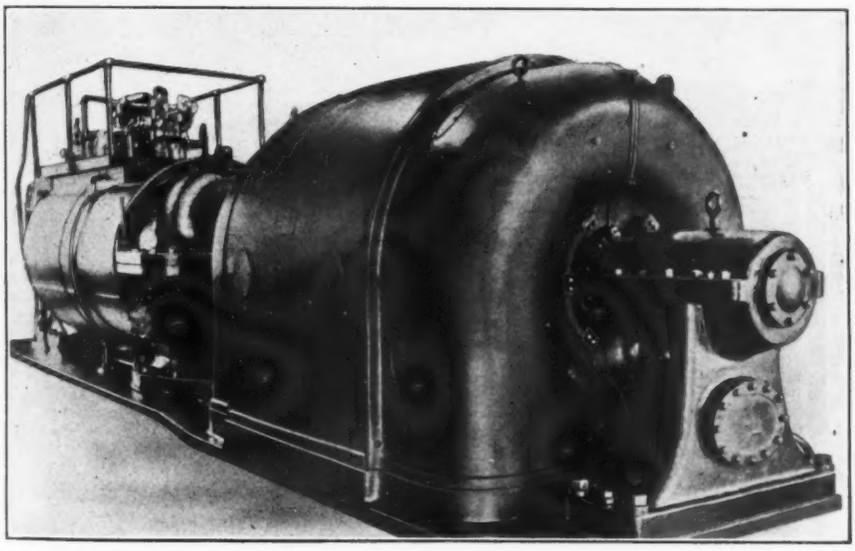

FIG. 7. GENERATOR END OF 3000-KILOWATT WESTINGHOUSE TURBINE

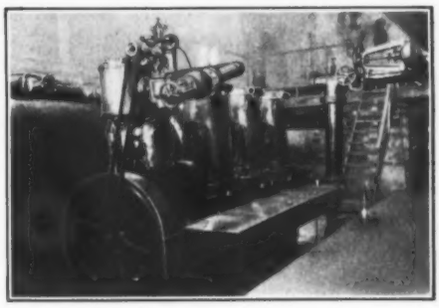

FIG. 8. AUXILIARIES OF 3000-KILOWATT TURBINE UNIT

### Motor-generator Sets

As previously mentioned, all that remains of the original engine equipment is one cross-compound Buckeye engine. This is rated at 1200 horse-power, has cylinders 24x46x36 inches, runs at 127 revolutions per minute, and is connected by rope drive to a small portion of the original line shafting. An extension of the main header leads to this engine through a Davis reducing valve, cutting down the steam pressure to 150 pounds. A cast-steel separator drained by an Anderson trap is in the line above the throttle. This separator is supplied with a pop valve set at 160 pounds to guard against the engine being subjected to excessive pressure. On the line shafting to which this engine is connected through a friction clutch, is one 500-kilowatt Westinghouse synchronous motor, or generator, 4800-volt two-phase, and one 500-kilowatt Westinghouse 600-volt direct-current machine. This forms a motor-generator set, the flexibility of which is at once apparent; for when running as a synchronous motor the alternator can help out the direct-current load, or *vice versa*, or the engine can run the two machines as generators at times of heavy load.

In addition to this set so fortunately arranged, there is another motor-generator set, which is shown at the extreme left in Fig. 5, and consists of a 720-horse-power Westinghouse two-phase 4800-volt synchronous motor driving a 500-kilowatt direct-current 600-volt generator, the set running at 514 revolutions per minute.

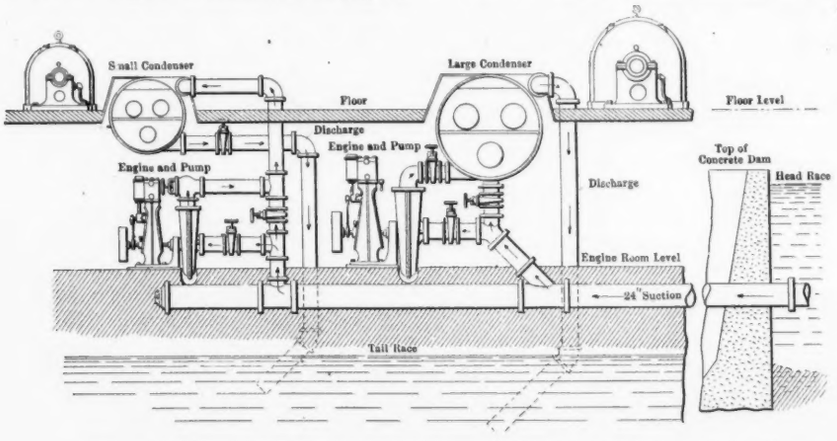


FIG. 9. CONNECTIONS WHICH PERMIT OF SIPHONING COOLING WATER

### Excitation

Alongside of the large Buckeye engine is a steam-driven exciter set consisting of a simple non-condensing Buckeye, 12x18 inches, running at 250 revolutions per minute and driving a 150-kilowatt 125-volt Westinghouse generator. This unit, which is shown in Fig. 10, is able to carry the entire excitation load of the station, but is used only in emergencies. Ordinarily exciting current is generated by two 50-kilowatt 125-volt Westinghouse generators direct-connected to water-wheels in the right wing of the water-power house, operating policy being to utilize water power as much as possible.

As a further reserve, a motor-driven exciter set, shown in Fig. 11, is provided, and consists of one 150-horse-power 4800-volt synchronous induction motor driving two 56-kilowatt 125-volt Westinghouse generators.

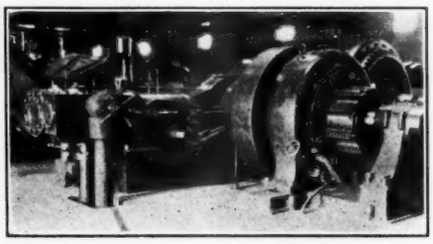

FIG. 10. STEAM-DRIVEN EXCITER SET

### Water-power Equipment

Figs. 12 and 13 show exterior and interior views of the water-power house, where, in addition to the exciters mentioned, two 600-kilowatt, 4800-volt, two-phase, revolving-field Westinghouse generators and one 600-kilowatt, direct-current, 600-volt Westinghouse generator are driven by 18 water-wheels, six to each unit. The line shafting is divided into sections which may be operated independently of each other, but which are ordinarily connected by friction clutches and run as one unit. In this way maximum power is obtained from the water-wheels at all times. For instance, if the direct-current load falls off, the excess power is taken up by the alternating-current machines, or *vice versa*. The wheels work to their full capacity continuously and the steam end of the system takes care of the fluctuations in the load, thus making it necessary to supply only that part of the demand for power in excess of what the water-wheels are able to furnish. In this way great economy in fuel is realized. Of the water-wheels installed, 14 are Triumph and six are Leffel wheels. Governors, of which there are two to each unit, are of the Woodward compensating type.

### Electrical Control and Distribution

Located in one end of the steam-driven station is the main switchboard, which is shown in Fig. 14, and consists of 21 white marble panels. Leads from the alternators are carried under the floor to the board in lead-covered cables, and in the case of the water-power generators, the leads pass over the tail-race in one span supported by steel cables. The board is provided with a duplicate set of bus-bars. Each generator panel carries one voltmeter, an ammeter on each phase, an integrating wattmeter, a polyphase recording wattmeter and two circuit-breakers. The output of each generator is

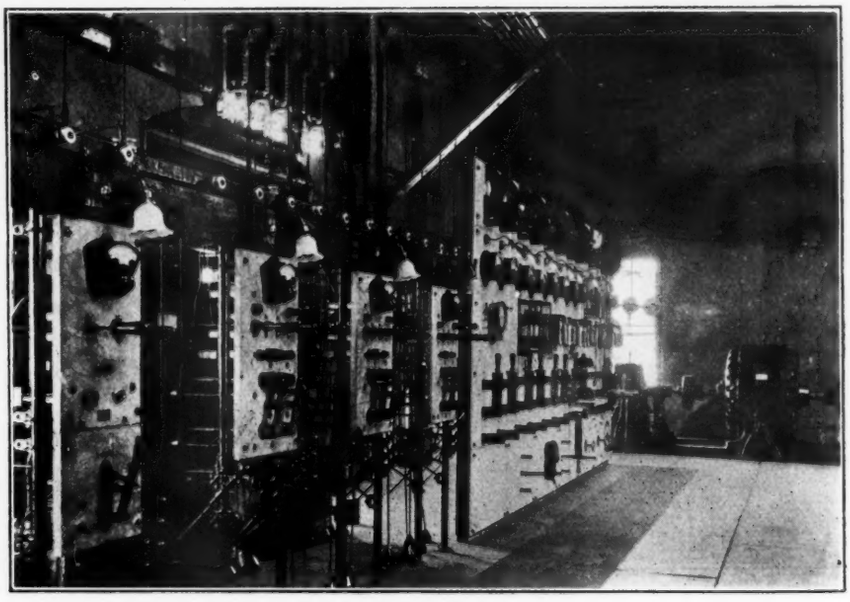

FIG. 11. SERIES-ARC PANELS, DIRECT-CURRENT SWITCHBOARD AND EXCITER SET

measured, and also that of each feeder, the total output being the sum of the generator readings.

All direct-current in the plant is controlled from the board shown in Fig. 11, which consists of 10 panels of white marble, three of which are exciter panels, and all of Westinghouse construction. Through this board passes all the 600-volt direct current used for local street railway service in the city of Moline. The 600-kilowatt direct-current water-power unit carries the bulk of this load and is assisted, when required, by either one of the motor-generator sets previously mentioned.

Another local service is that of the Moline arc-lighting system. To the left of the direct-current switchboard in Fig. 11 can be seen the controllers and panels for this service. There are four General Electric, 100-light series-arc controllers, type R N, of 71 kilowatts each; these furnish an all-night service using General Electric arc lamps of 2000 nominal candle-power. One 50-light Westinghouse controller is used for station lighting. All of these controllers take current at 4800 volts direct from the bus-bars, but are arranged to operate at 2400 volts if desired.

tion and series-arc lighting are handled through a sub-station, there being two 300-kilowatt, 60-cycle Westinghouse rotaries, one 200-kilowatt, 60-cycle rotary and two 500-kilowatt Westinghouse induction motor-generator sets. For mutual protection this system is tied with the power station at the Government arsenal on Rock Island, where there are three 600-kilowatt General Electric generators, driven by water power.

All circuits leave the power station on pole lines, the alternating-current circuits being protected by Westinghouse low-equivalent lightning arresters, and the direct-current lines by water rheostat arresters. As the greater part of the power load consists of synchronous motors, the power factor is high, averaging around 95 per cent., the only disturbing element being the induction motors on the factory loads and the induction motor-generator sets.

FIG. 12. EXTERIOR OF WATER-POWER STATION

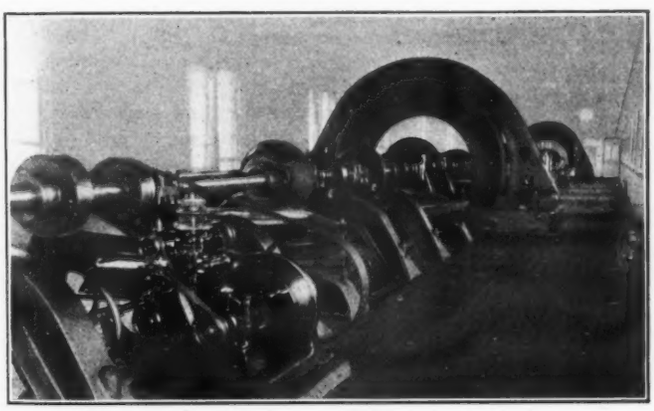

FIG. 13. INTERIOR OF WATER-POWER STATION

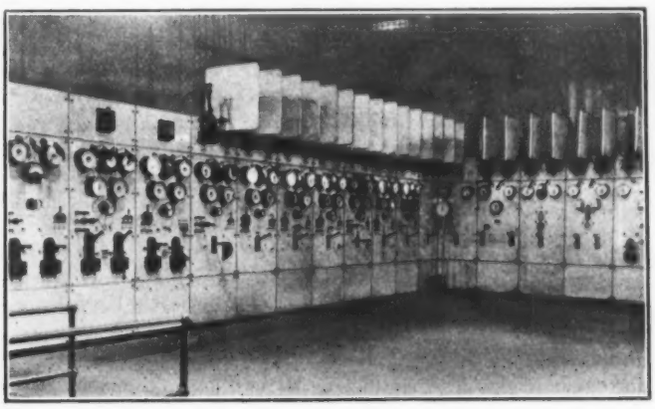

FIG. 14. ALTERNATING-CURRENT SWITCHBOARD

Incandescent lighting and power service for Moline is supplied by four 300-kilowatt Westinghouse step-down transformers furnishing two-phase current at 2400 volts. Moline is essentially a manufacturing city, and in addition to furnishing power and lighting for many of the factories, a breakdown service is supplied to others which are steam-driven. Factory power is taken from the 2400-volt mains, part of it being used at this pressure and the rest reduced to 440 volts.

### Sub-stations

Two 4800-volt lines run to the old Tri-City power station at Rock Island, which has been turned into a sub-station and takes care of the traction load at this point through two 400-kilowatt Westinghouse induction motor-generator sets, the alternating-current end being 60 cycles. Similarly a line extends to Davenport, a distance of three miles, where both traction and series-arc lighting are handled through a sub-station, there being two 300-kilowatt, 60-cycle Westinghouse rotaries, one 200-kilowatt, 60-cycle rotary and two 500-kilowatt Westinghouse induction motor-generator sets. For mutual protection this system is tied with the power station at the Government arsenal on Rock Island, where there are three 600-kilowatt General Electric generators, driven by water power.

This entire system recently came under the control of J. G. White & Co., of New York. J. F. Porter is president, F. W. Reimers is general superintendent and E. Cameron is chief engineer of power stations.

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Do not blow off under pressure when intending to clean out, as the heat of the boiler and the brickwork will bake the mud and scale on the shell and tubes, making it extremely difficult to remove. Allow the boiler and brickwork to cool. The boiler should then be drained and thoroughly cleaned and washed out both from the top and bottom. The boiler should be cleaned out at intervals frequent enough to keep it clean and free from scale.

## "Bulls" in Designing

By George R. Williams

The designing of isolated and central power stations is too often intrusted to persons who, through lack of training and experience, are able to see only the theoretical side, and, therefore, many plants have had to be reconstructed by the practical men placed in charge. Following is a case in point, where, although many of the obstacles are being overcome by the chief engineer, to remove all the defects would mean the rebuilding of the major part of the plant. While the plant was in process of preparation several of the errors most in evidence were pointed out to the designing engineer, but he could not, or would not, see them.

From a careful survey it is apparent that the first cost might have been less. The boiler room contains six 500-horse-power water-tube boilers equipped with underfeed stokers supplied with coal through spouts from an overhead bunker having an inclined bottom slanting toward the boiler fronts. This bunker is served with coal by a traveling hoist and clam-shell bucket filled by hand with coal unloaded from cars by hand. In winter several extra men are required to break the frozen coal into convenient size for handling. The bunker has no covering, and in summer the rain caught by it is conveyed to the stokers through the spouts, while in cold weather the coal must be constantly gone over and kept from freezing by picking.

The boilers were erected first. Then came the structural-iron workers, who put up the bunker; when they had completed their work the plate girder supporting the inside wall projected a little below the bottom of the steam drums and cleared the man-head dogs by 1 inch.

Of course, the front manholes are never used, as a man cannot enter the drums through them. As the girder was placed so close, the water columns had to be moved around to the side of the boilers. This makes it necessary for the water

tender to go back between the boilers and look toward the front to see the water gages, the ironwork cutting off the view from every other point.

The bunker supporting columns are so spaced that three of them come in front of the boilers and so close that only one header door on each boiler can be opened; the other doors must be taken down with block and tackle when cleaning day comes.

The tubes in these boilers are 18 feet long, and the front wall of the boiler room is 14 feet from the headers. When it becomes necessary to remove a tube and put in a new one, that does not come in line with a window, a hole must be cut through the brick wall to permit its passage. The wall now looks like a pepper-box cover.

### Passage of Flue Gases

The flue gases reach the draft fans either by way of an economizer or through a bypass. This bypass is so placed that there is a 16-inch space between it and the rear heads of the steam drums. Owing to the front manholes being useless, the boiler washer must do all his crawling in and out through this narrow opening. And the smoke box is generally hot. The underfeed stokers require an air blast which is furnished by a fan driven by a direct-current motor. Recently this motor stopped, and naturally the whole plant also stopped until a steam engine could be borrowed and arranged to supply air while the motor was being repaired.

The engine room contains, along with the other apparatus, two 1200-kilowatt three-phase generators directly driven by horizontal cross-compound engines with 26 and 52x48-inch cylinders. Overhead is a 10-ton hand-power traveling crane. Many parts of these engines weigh more than the capacity of the crane. It was pointed out to the designer that if he installed a 20-ton crane the engines would be put in enough cheaper to more than pay the difference in cost of the cranes. Nevertheless a 10-ton crane is there.

As there was no floor capable of carrying these heavy parts it was necessary to build up with timber cribs from the basement and bring in all pieces weighing over 10 tons on rollers and "spot" them with the crane on one side and chain hoists on the other. This was an expensive process, but it was foreseen and added to the cost of the engines by the builders.

### Steam Pipes

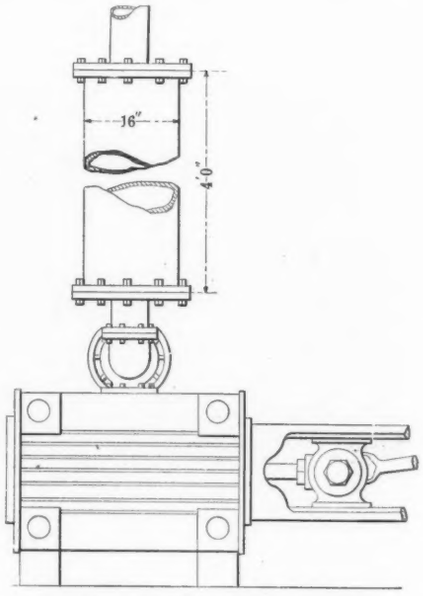
The plans showed steam pipes coming from the header in the boiler room through the engine-room wall above the crane track and down to the engines. After the piping was put up according to specifications, the designer was asked how the crane was to be moved from one end of the building to the other. Then the header was lowered 5 feet and the pipes brought in below the track. It cost only about $300 to remedy that error.

The company owning this plant also operates a heating system for residences and business blocks. In the old plant this water was heated by exhaust steam from the non-condensing engines and gave the station force very little extra work. When the new power house was built the consulting engineer, instead of providing a way to heat this water with live steam, exhaust steam before entering the condensers, or with flue gases, piped it through one-half of each condenser. The ever-changing temperature of the water on its return from the mains keeps the 3200 tubes constantly expanding and contracting, and the repairman busy packing them. A man must be stationed at each circulating-water valve to change the volume of water according to the engine load; when the load comes on suddenly as is common in interurban service, the valve must be whirled open, or the vacuum is lost. When the load drops the valve must be "pinched" down, or the heating water is chilled. In cold weather a vacuum of from 16 inches to 20 inches is the maximum. The only nice feature of this arrangement is that it gives employment to a few additional men. In the former station there were some 125-volt direct-current generators which the designer decided to use for exciting the fields of the new alternators. The chief operating engineer made a plea for steam or motor-driven exciters, but was laughed at. "What was the use of buying new machines when the old ones would do?" They were installed, one between the cylinders of each engine and driven by belts from the fly-wheels. The latter are 17 feet in diameter and the exciter pulleys are 30 inches; when the engines are running at the normal speed of 96 revolutions per minute the exciters make 653 revolutions per minute. With an increase of load the engine naturally drops its speed a little momentarily, and if this decrease is only 2 per cent., and it is often more on an overload, the exciter speed falls to 639 revolutions per minute, with a disastrous effect on the voltage of the generator output, which would drop as much as 35 volts for a few seconds until the engine could "pick up" again, which is plainly noticeable. While not affecting the traction service, this defect lost the company nearly all its incandescent-lighting business. This variation was blamed on the engine's governor, and after several weeks of testing, altering and adjusting by competent mechanical engineers the trouble was placed on the generators. Then came an electrical engineer, and the two put in some more time and decided they didn't know what was the matter unless the governor springs were too weak. The erecting engineer, who had installed the engines, came next to put two more leaves in each spring. He claimed, as he had from the first, that the trouble was easily traceable to the exciters, and to prove it he ran No. 2 engine simply to excite No. 1 generator, and the problem was solved. The voltage varied less than eight volts on a load for one generator varying from 200 kilowatts to 1450 kilowatts and back again. However, it was out of the question to operate in this manner, so after many mathematical calculations it was decided to put in a voltage regulator as the cheapest way out of the difficulty. This was done, and now the load is carried very nicely, but it cost a bunch of money, as the owners had to pay for the experimenting it required to locate the trouble, all agreeing it was not the fault of either engines or generators, but simply a "bull" on the part of the designer.

## A Steam Reservoir

By W. H. Wakeman

Some time ago I saw a reservoir or a receiver for steam on the main pipe of a Corliss engine, and as the idea may be




STEAM RECEIVER ABOVE THROTTLE

valuable to others it is presented here. The steam pipe for this engine is 5 inches in diameter and about 150 feet long. It was thought that such a long pipe would cause a serious reduction of pressure in the cylinder, from the amount carried on the boilers, hence a piece of 16-inch pipe 4 feet long was secured and was placed above the cylinder, as shown in the illustration. A standard 23½-inch flange was screwed on each end of this pipe and to the flanges were bolted reducing flanges, 23½x5 inches. This was attached to the throttle valve by a short nipple at one end.

Under ordinary conditions this engine cuts off at about one-quarter stroke, and when the steam valve opens at the beginning of the stroke, there is an ample

supply of steam at hand to fill the cylinder and maintain the initial pressure to the point of cut-off, which results in securing more power than would be developed if the initial pressure was 10 or 15 pounds less than boiler pressure and still less at the point of cut-off. The diameter of the engine cylinder is 16 inches, so that the capacity of both reservoir and cylinder per inch of length is the same. Consequently, when comparing the total capacity of the former with the amount required to fill the latter to the point of cut-off, it is only necessary to compare the lengths given. The stroke is 36 inches, and when cutting off at one-quarter stroke, the cylinder must be filled for 9 inches of its length, and as the reservoir is 48 inches high, less than one-fifth of its capacity is taken at each stroke of the engine.

The only way to determine the actual value of this reservoir is to secure indicator diagrams with and without it, while carrying the same load, but inasmuch as this is not practical, the following calculation will give some light on the subject. Suppose that under working conditions the inlet of this reservoir should be closed the instant that a stroke of the piston is begun, with 100 pounds pressure by the gage. When the cut-off valve closes, the pressure will be reduced about 20 pounds as follows: If the gage pressure is 100 pounds, the absolute pressure is about 115 pounds. The area of a 16-inch circle is 201 square inches, and as the reservoir is 48 inches long, it contains

$$201 \times 48 = 9648$$

cubic inches.

Cut-off in the engine cylinder takes place when the piston has traveled 9 inches; therefore, it takes

$$201 \times 9 = 1809$$

cubic inches of steam at each stroke, leaving

$$9648 - 1809 = 7839$$

cubic inches in the reservoir. Multiplying this by the pressure per square inch, and dividing the product by the volume to which the steam expands, gives the final pressure. Then

$$\frac{7839 \times 115}{9648} = 93$$

pounds absolute, or 78 pounds gage pressure. The lower nipple, the throttle valve and the steam chest hold enough to increase the pressure to 80 pounds.

Under normal conditions the inlet to the reservoir is open, hence as soon as the pressure begins to fall, steam from the boilers rushes in at once through a pipe as large as the outlet, and the pressure is probably not reduced more than five pounds. When a reservoir is used it should be well covered with a good nonconductor, as the radiation will be excessive without it. It should be used several days under full pressure, after which the nuts ought to be tightened when comparatively cool, in order to compress the packing thoroughly before the nuts are covered with asbestos or magnesia. This will assure tight joints.

## Notes on Cooling Towers

By William Sangster

I saw Smithers last week, who said times were such that a man must look around to see where the corners could be cut. He had a 250-horse-power noncondensing Corliss engine, and intended to add a condenser in order to save fuel. The question of water supply had bothered him, until he ran across some literature on methods of cooling condensing water and using it over and over again. He accordingly decided to use a cooling tower which could be placed in a convenient corner without using much ground space.

### Cooling-tower Method

In the cooling-tower method, the hot water is pumped and distributed over the tops, and flows down the sides of a checkerwork of boards, tiles, or other convenient material, placed edgewise so as to offer the least resistance to the currents of cooling air which cool it by evaporation and contact.

In cooling by contact he estimated that each cubic foot of air takes up about 0.02 heat unit for each degree Fahrenheit rise in temperature. In cooling by evaporation he estimated that each pound of water turned into vapor required approximately 1000 heat units, and as each pound contains 7000 grains it required

$$\frac{1000}{7000},$$

or 0.14 heat unit for each grain of water.

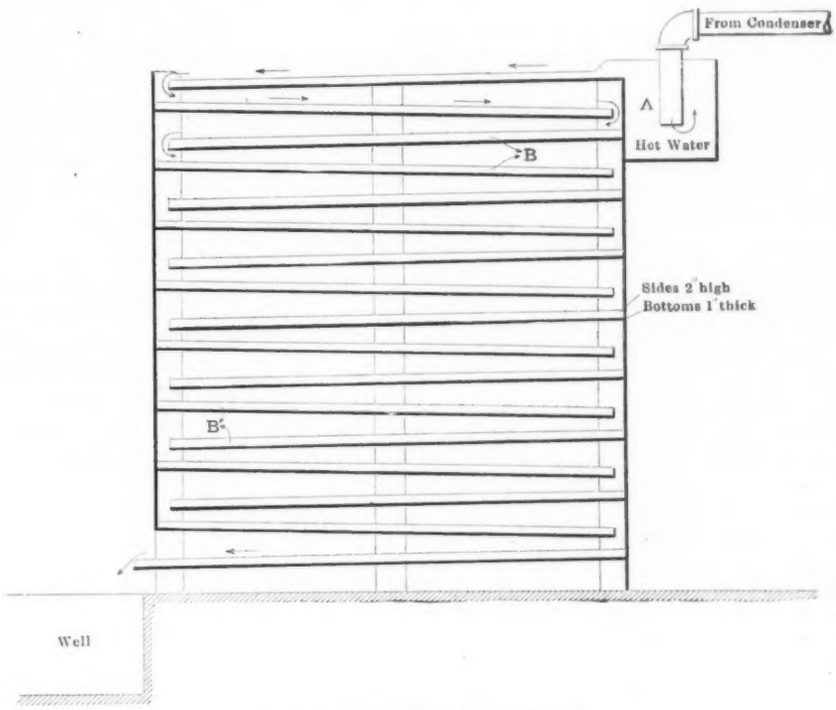



FIG. 1. THE SHALLOW-PAN IDEA

### Evaporative Method

The evaporative, or shallow-pan idea, arranged as per Fig. 1, first appealed to him. The hot water is pumped into the trough *A* and flows over the edge in a wide, thin stream over the pans *B*, in the direction shown by the arrows, until it is properly cooled, and then falls into the well.

After looking into the plan he found two serious objections: The first was the large amount of floor space required, even if he placed the well under instead of on one side of the cooler, as shown; the second, and more serious objection, was that it would be necessary to place the cooler on the roof in order to secure the advantage of the air currents. Even then, unless on a windy day, little or no air would pass between the pans, and the cooling effect would, therefore, be small.

He went on to say that naturally in cool, dry weather, the cooling capacity of the air is greater than in hot weather, especially if the humidity is high. The curves in Fig. 2 may make this clearer, as they show the grains of water contained in each cubic foot of air between 30 and 130 degrees Fahrenheit and at 50, 75 and 100 degrees saturation.

### An Example

He assumed, for example, that the water from the condenser is at 110 degrees, and it was cooled to 90 degrees, with the air at 75 degrees and 75 per cent.

saturation. At 75 degrees and 75 per cent. saturation each cubic foot of air contains 7 grains of moisture. Warm it up to 100 degrees and 100 per cent. saturation and it contains 20 grains, or an increase of 13 grains. Then as each grain of water evaporated into vapor requires 0.14 heat unit, each cubic foot of air will have taken up $0.14 \times 13$, or 1.82 heat units. To heat the air from 75 degrees to 100 degrees means 25 degrees rise, and as each cubic foot for each degree rise requires 0.02 heat unit, it will take up $25 \times 0.02$, or 0.5 heat unit; or a total of $1.82 + 0.5 = 2.32$ heat units for each cubic foot of air passing through the tower.

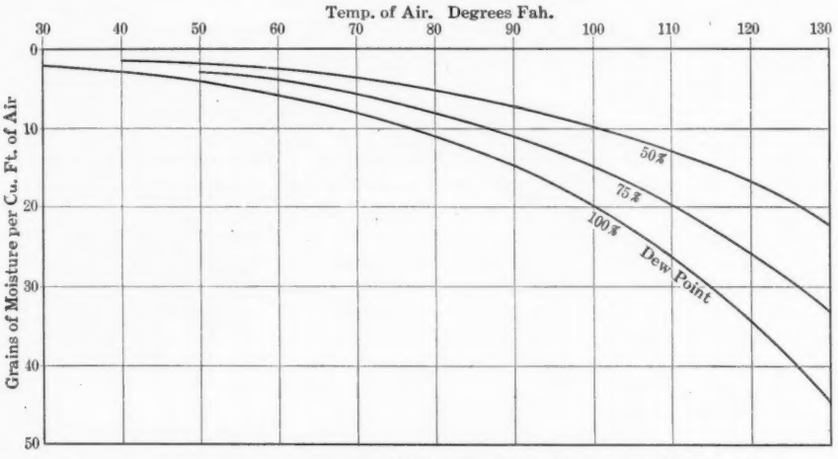



FIG. 2. CURVES SHOWING WATER CONTAINED IN EACH CUBIC FOOT OF AIR

As his engine used about 24 pounds of steam per horse-power hour, and he allowed 30 pounds of water to condense each pound of steam, he would use approximately $24 \times 250 \times 30 = 180{,}000$ pounds of water per hour, or 3000 pounds of water per minute. As the water is cooled from 110 degrees to 90 degrees, it gives up about $3000 \times 20 = 60{,}000$ heat units and requires $60{,}000 \div 2.32 = 26{,}000$ cubic feet of air per minute, nearly.

If the air is at 40 degrees, saturation being 100 per cent., and is warmed to 90 degrees — 100 per cent. it will absorb 12 grains of moisture, or 1.68 heat units by evaporation and $50 \times 0.02 = 1$ heat unit by contact, a total of 2.68. The air required to cool the water is $\frac{60{,}000}{2.68} =$ 22,400 cubic feet per minute, nearly. In summer, with the thermometer at 90 degrees and saturation at 75 degrees, each cubic foot of air contains 11 grains of moisture. By raising it to 110 degrees and 100 per cent saturation, it will absorb 15 grains, or 2.1 heat units by evaporation, and 20 degrees, or 0.4 heat unit by contact, making a total of 2.5 heat units. The air required for cooling is

$$\frac{60{,}000}{2.5} = 24{,}000$$

cubic feet per minute.

### Size of Tower

He estimated the size of his tower by what he found to be good, safe practice, which allows approximately 0.2 square foot of tower area for each horse-power in the engine, when the checkerwork is composed of smooth surfaces placed in a smooth cylindrical casing. Expressed in a formula it reads:

$$D = \sqrt{\frac{H.P.}{4}},$$

where

$D$ = Diameter of the tower in feet,
$H.P.$ = Horse-power of the engine.

Since he decided to make the checkerwork and casing of unplaned cypress, he decided to make the tower somewhat larger in area, or square instead of round. For his engine, the diameter would be

$$D = \sqrt{\frac{250}{4}} = 7.9,$$

or in round numbers, 8 feet.

### Construction

The checkerwork was arranged as shown by Fig. 3, and consisted of 1-inch boards placed 8 inches center to center, as indicated by the full lines, forming a tier about 18 inches high. The next tier was arranged to break joints, as shown by the dotted lines, so that at the intersection of the tiers the spaces for the air passages were 3x3 inches instead of 7x7 inches. This arrangement divides the air into a large number of small streams and impinges it more directly on the water flowing over the checkerwork. He learned that some designers inclose the top of the tower by a cone-shaped cover in the center of which enters the discharge pipe from a centrifugal blower which forces cool air in at the top and discharges it at the bottom. The claim for this is a higher cooling efficiency of the air. The usual method is to admit the cool air at the bottom and secure the benefit of the upward and natural current of the air as it becomes heated.

The other proportions of his tower are shown by Fig. 4, and the following dimensions (the unit $D$, or diameter of the tower, has already been determined):

Diameter ($D$) of tower, 8 feet.
Hight of checkerwork, $H = 1\frac{7}{8}\ D =$ 15 feet.
Diameter of fan, $B = \frac{5}{8}\ D = 5$ feet.
Hight of well, $L = \frac{5}{8}\ D = 5$ feet.
Diameter of well, $W = \frac{5}{8}\ D = 5$ feet.
Hight of chamber, $C = \frac{5}{8}\ D + 1 = 6$ feet.

As already noted, the air supply must have a maximum of at least 26,000 feet per minute. To meet contingencies and for warm saturated air, an allowance of 50 per cent. should be made; in this case calling for an air supply of 40,000 feet per minute. Smithers discovered that he could not secure a sufficient volume from the natural flow of the heated air, as he found in "Kent" that after allowing for loss in velocity, due to the rough passages, he could figure on a flow of but

$$V = 240\sqrt{\frac{h\,(t_1 - t)}{t}},$$

where

$V$ = Velocity of air in feet per minute,
$h$ = Hight of the tower in feet,
$t_1$ = Temperature of the heated air,
$t$ = Temperature of the entering air.

Temperatures $t_1$ and $t$ are those shown by the thermometer, plus 460 to bring them to absolute temperature.

Taking an average weather condition in the summer, entering air 75 degrees, heated air 100 degrees, and the tower $1 + 15 + 3 = 19$ feet from the top to the

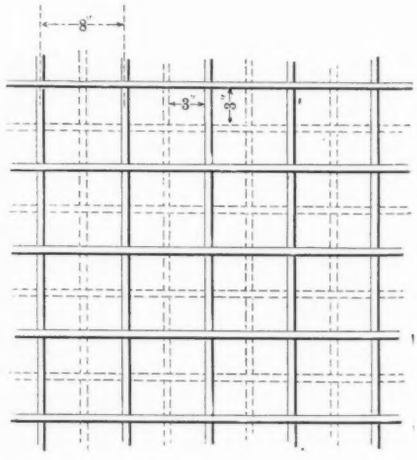



FIG. 3. CHECKERWORK CONSTRUCTION

center of the fan opening, he found his velocity to be

$$V = 240\sqrt{\frac{19'(560 - 535)}{535}} = 226$$

feet per minute.

### Volume of Air

Since his tower has at the intersections of the tiers 1 inch of lumber and 3 inches of space, it follows that it has but 75 per cent. free area, or $8 \times 8 \times 0.75 = 48$ square

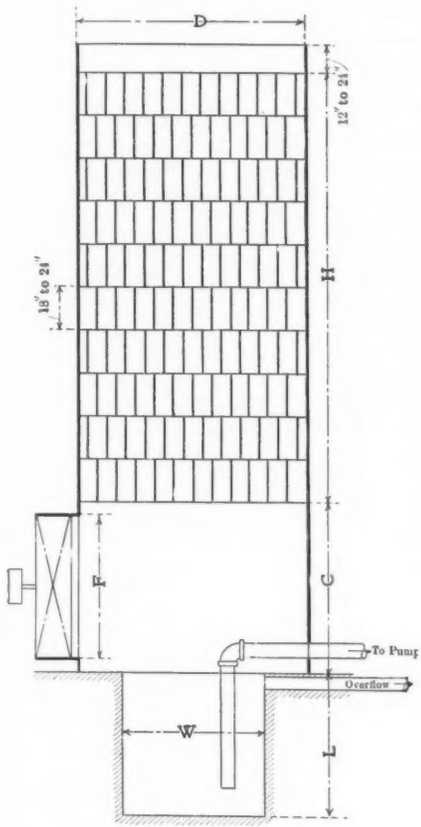



FIG. 4. DETAILS OF COOLING TOWER

feet. The volume of air passing through the tower is then $48 \times 226 = 11{,}850$ cubic feet per minute, or about one-fourth that which should be provided for the successful operation of the tower. In order to secure a proper volume of air some mechanical means is necessary, and a fan of either the centrifugal or disk type is usually employed. The disk fan is preferable as it is lighter and requires less foundation, or support, than the centrifugal fan, besides being cheaper in first cost.

The volume of air delivered by a disk fan may be found from the formula:

$$V = 0.67\ D^3\ N,$$

where

$V$ = Volume in cubic feet per minute,
$D$ = Diameter of the fan in feet,
$N$ = Revolutions per minute.

Knowing the diameter of the fan as 5 feet, and the volume of 40,000 feet, he found the revolutions to be

$$N = \frac{V}{0.67\ D^3} = \frac{40{,}000}{0.67 \times 125} = 480$$

revolutions per minute.

The power required to drive this fan is found from the formula

$$H.P. = \frac{D^5 \times N^3}{25{,}000{,}000},$$

where

$H.P.$ = Horse-power required by the fan,
$D$ = Diameter of fan in feet,
$N$ = Revolutions of fan per minute.

In this case $D = 5$; $N = 480$ $H.P. =$

$$\frac{3125 \times 110{,}592{,}000}{25{,}000{,}000{,}000} = 13.8$$

horse-power.

It will be noted from the last two formulas that the volume of air delivered by a fan varies directly as the speed; the horse-power required to drive a fan varies as the cube of the speed. If the fan can be run at one-half of the speed as given above it will, at 240 revolutions per minute, deliver about 20,000 cubic feet of air per minute and require but one-eighth of the power, or approximately 1.7 horse-power. The fan should be driven by an independent engine or variable-speed motor and the speed of the fan, with corresponding changes in volume delivered and power required, varied to suit existing weather conditions. Of course, the condensing water may be cooled lower than 90 degrees, as shown by the example, especially in dry weather. The cooling effect due to contact is greater in cold weather, while in hot weather the effect due to evaporation absorbs the greater percentage of the heat.

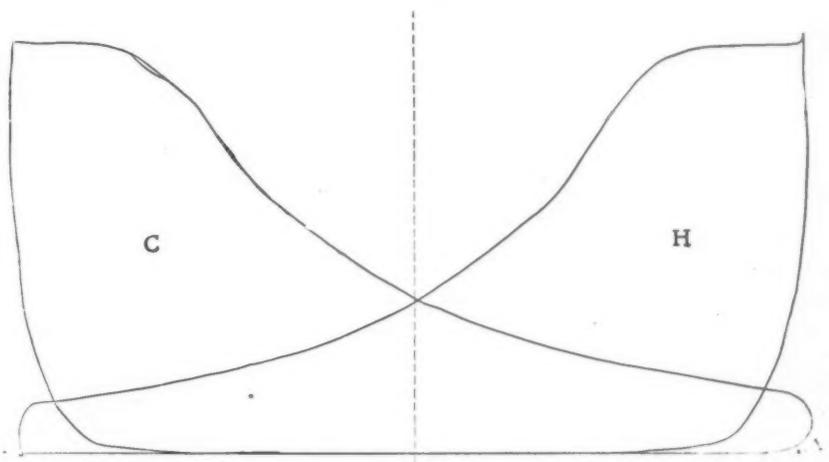
## Points on Indicator Practice

By Charles B. Risley

It is an evident fact that many engineers do not know of or at least do not use a suitable paper for the indicator, for there are a great many kinds of paper, good and bad, and mostly the latter. A good selection is a white paper of such thickness as to work well on the drum of the indicator, yet light enough so that the lines may be readily seen through the paper when it is folded and held to the light. Try the paper with a lead pencil to see that a clear, visible line may be made upon it with a very moderate pressure of the pencil. If any printing is desired on the cards, do not have it upon the back, but place it above the space to be occupied by the diagram. A large percentage of diagrams are practically worthless, except to show the lines made by the indicator. It is always a good idea to have detailed information concerning the engine and conditions, together with a complete diagram, especially if a presentable card is wanted. Cards from compound engines should show diagrams taken at the same instant from both the high- and low-pressure cylinders.

After taking a diagram the first things to notice are the steam distribution and valve setting. It is, of course, possible by means of the planimeter to measure the diagrams from each end of the cylinder, and by so doing arrive at the amount of power produced by each stroke of the engine, but this does not mean that the valve adjustment is equal for both strokes, and on the other hand the planimeter is too slow a process for valve setting. Here is a better way:

Take the card and bring the ends together, hold the paper between the eye and the light and shift the ends of the card until the points $A\ A$, shown in the card herewith, are exactly one over the other and the two halves of the atmospheric line coincide. Then make a comparison of the diagrams, and the difference in steam distribution can be seen at a glance. When the valves have been brought to an adjustment so that the diagram from one end follows exactly over the diagram of the other end, then the performance of the engine is equal in both ends of the cylinder.




TO DETECT THE DIFFERENCE IN STEAM DISTRIBUTION

By applying this suggestion it will be found that much better looking cards will be obtained and likewise a much more accurately adjusted engine; guesswork will be eliminated and time saved.

# The Operation of Electrical Machinery

## Alternating-current Armature Connections; Keeping the Voltage Constant; General Rules for the Management of Rotary Converters

BY NORMAN G. MEADE

### Alternating-current Armature Connections

The armature connections of a single-phase alternator armature are shown in Fig. 1, those of a two-phase machine in Fig. 2 and those of a three-phase star-connected armature in Fig. 3; Fig. 4 gives the connections of a three-phase delta-connected alternator armature.

It makes no difference whether the field magnet or the armature of an alternator is the revolving part, because there is no commutator and, therefore, the brushes do not have to bear any fixed relation to the armature or field magnet. When the

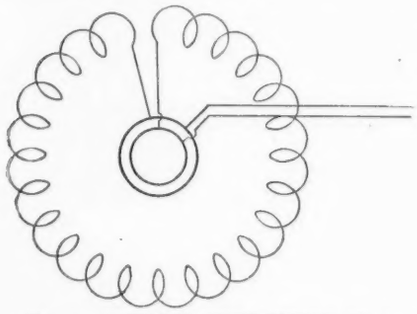


FIG. 1. ARMATURE CONNECTIONS OF A SINGLE-PHASE ALTERNATOR

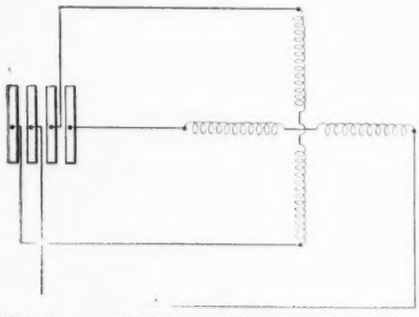


FIG. 2. ARMATURE CONNECTIONS OF A TWO-PHASE ALTERNATOR

field magnet revolves, the armature is stationary and the current is carried out and back by the leads connected directly to the winding. Two collector rings and brushes are necessary for connecting the source of exciting current with the winding on the revolving field magnet. This is shown in Fig. 5, which illustrates an alternator of the revolving field-magnet type. Fig. 6 shows the armature of another machine of this type.

### Voltage is Constant

In most alternating-current systems the voltage at the points from which the current is distributed is constant, or as nearly so as possible. This means that the electromotive force at the terminals of the alternator must, as a rule, rise slightly as the load comes on, the amount of rise depending upon the drop in the line; therefore, it is necessary to strengthen the field excitation as the load increases. This is sometimes accomplished by a compensating winding, the connections of which are shown in Fig. 7; this winding varies the excitation of the field magnet in proportion to the current which the machine is supplying, like the compound winding on a direct-current dynamo. The main winding, corresponding to the shunt field winding of a compound-wound dynamo, is separately excited and produces the magnetism necessary for the generation of the full voltage at no load; the auxiliary winding furnishes the additional magnet-

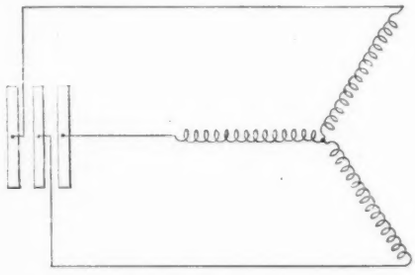


FIG. 3. ARMATURE CONNECTIONS OF A THREE-PHASE ALTERNATOR; STAR WINDING

ism necessary to supply the extra voltage required to compensate for the drop at full load. The current flowing in the series coils is "rectified" by a special commutator—that is, changed from alternating to a pulsating direct current.

### Rotary Converters

In systems of power distribution it is frequently necessary to transform from direct to alternating current or *vice versa*. This is accomplished by means of rotary converters. A rotary converter is provided with an armature which is similar to that of a direct-current generator, with the addition of collector rings, which are connected by "taps" to equidistant points in the armature winding; each collector ring of a single-phase, two-phase or three-phase machine is connected with as many taps as there are *pairs* of field-magnet poles. Fig. 8 shows the connections of a single-phase rotary-converter armature.

A rotary converter is very flexible as to application. It may be supplied with direct current and made to deliver alternating current, or it may be supplied with alternating current and made to deliver direct current. It may be operated as a simple alternating-current synchronous motor or as a simple direct-current motor. It may be driven by mechanical power and made to deliver alternating current alone, direct current alone, or both alternating and direct current at the same time. It may be operated as a converter of either direct current to alternating, or alternat-

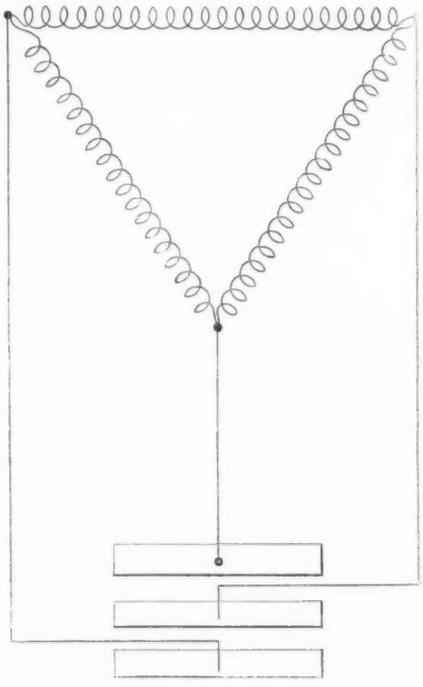


FIG. 4. ARMATURE CONNECTIONS OF A THREE-PHASE ALTERNATOR; DELTA WINDING

ing to direct, and at the same time deliver mechanical power from a pulley on its shaft. Standard rotary converters are, however, built for use as rotary converters only; that is, for transforming alternating current into direct, or direct current into alternating. Ordinarily the shaft and bearings are designed only to carry the armature and not to receive nor transmit mechanical power. The relation between the armature and field magnet is such that if the converter be operated as either a direct-current or alternating-current generator it may not give satisfactory results, unless designed especially for such use.

The rotary converter can be operated in

parallel with other rotary converters or with other generators, and it can be parallel at either the supply or delivery side, or both simultaneously. Rotary converters at different stations can be connected to one set of mains, providing their voltage is properly adjusted. Two rotary converters can be operated in series for a

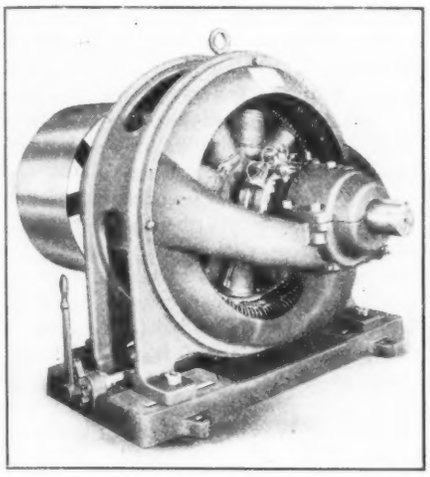


FIG. 5. REVOLVING-FIELD-MAGNET ALTERNATOR

three-wire system, providing the alternating current is supplied from separate secondary circuits.

The ratio between the alternating and the direct-current voltages of a rotary converter is approximately constant, and cannot be changed by altering the speed, or by using a rheostat, although it is varied slightly by changes of load on the converter. Therefore, any change in

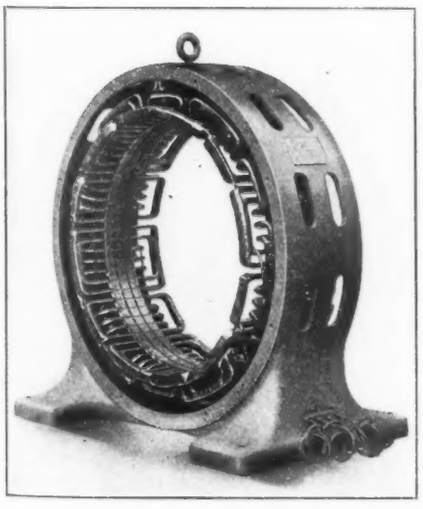


FIG. 6. STATIONARY ARMATURE OF A REVOLVING-FIELD ALTERNATOR

either voltage will proportionately change the other.

In most standard rotary converters the voltage between the collector rings of a two-phase machine is about seven-tenths of that between the commutator brushes, and the voltage between the collector rings of a three-phase converter is about six-tenths of that between the commutator brushes.

For example, a two-phase converter receiving alternating current at 388 volts will deliver current at approximately 550 volts, and a three-phase converter receiving 337 volts will deliver approximately 550 volts.

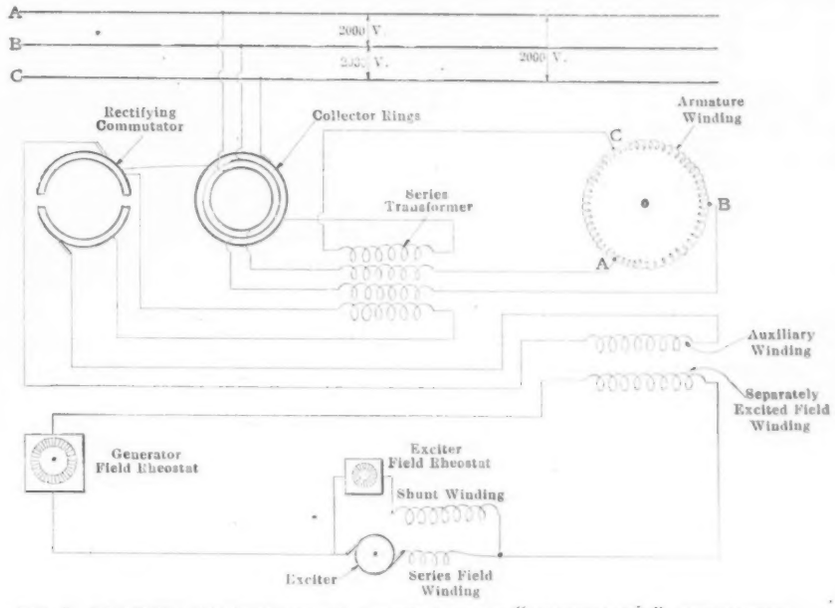



FIG. 7. COMPLETE CONNECTIONS OF A THREE-PHASE "COMPENSATED" ALTERNATOR AND ITS EXCITER

Two voltages may be obtained from a two-phase rotary converter. If a conductor be connected to the middle point of the secondary winding of the transformers which supply the converter, the electromotive force between this conductor and either of the direct-current brushes will be equal to one-half the electromotive force between the brushes. In this way 110 volts can be obtained from a 220-volt converter. This method is used in a number of places for supplying a three-wire lighting system from 220-volt rotary converters, as shown diagrammatically by Fig. 9. In some plants this method is employed for obtaining two voltages for operating variable-speed direct-current motors or other purposes.

The rotary converter may be started up with alternating current as a synchronous motor, which develops a satisfactory torque only after having been brought up to normal speed. Hence, although it is possible to start a converter directly from the alternating-current supply circuit, this method is objectionable because of the excessive current, of low-power factor, drawn from the mains; such draft of current impairs the regulation of other apparatus on the same circuit. This method of starting is only permissible when the capacity of the converter is small compared to that of the generator.

A second method of starting a rotary converter is to treat it as a direct-current motor, supplying direct current to the commutator brushes and, when it has reached synchronism, connecting it to the alternating-current circuit. This method is satisfactory, but it obviously requires a supply of direct current, which may not always be available in an alternating-current station or sub-station.

A third method, and the one which is now standard practice, is to start the converter by means of a small induction motor mounted on the converter shaft, as shown in Fig. 10; when the converter armature is brought up to synchronous speed, it is connected to the alternating-current supply circuit.

There are several methods by which the direct-current voltage delivered by a rotary converter may be varied, all of which depend upon the proper variation

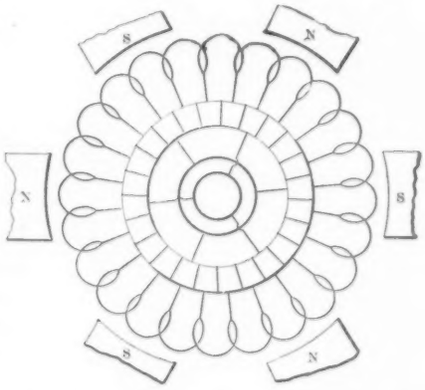



FIG. 8. ARMATURE CONNECTIONS OF A SIX-POLE SINGLE-PHASE ROTARY CONVERTER

of the voltage of the alternating current supplied. If the voltage of the supply circuit be raised or lowered, the delivered voltage of the converter will be varied accordingly. The ratio of the transformers through which the alternating current passes may be changed to produce the desired variations in voltage delivered by

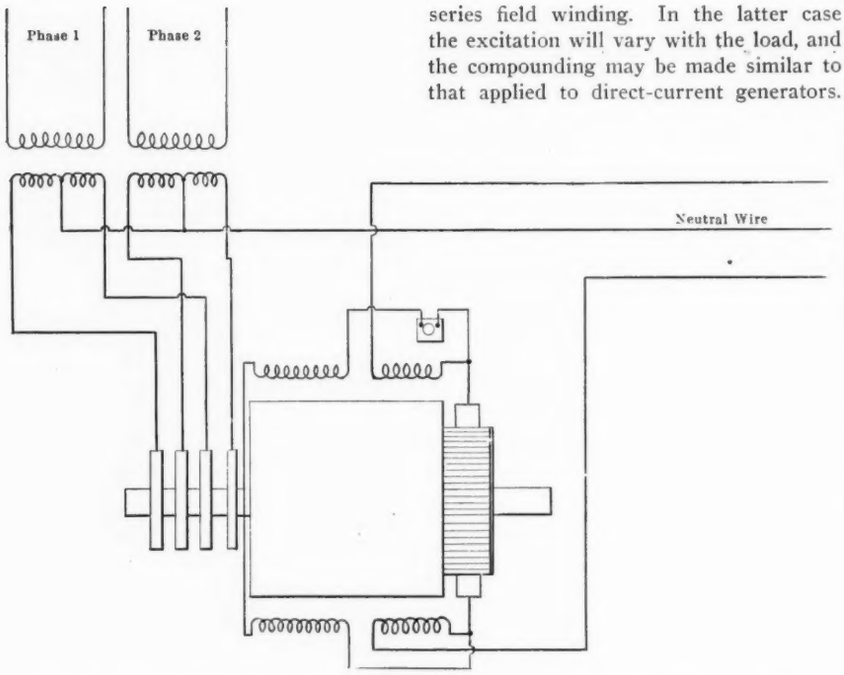



FIG. 9. CONNECTIONS OF A TWO-PHASE ROTARY CONVERTER SUPPLYING A THREE-WIRE DIRECT-CURRENT SYSTEM

them. For this purpose taps may be brought out from the windings of the transformers so that any desired ratio may be obtained. The ratio may be changed by altering the connections when the converter is not in operation, or, if a suitable regulator is provided, the change of the ratio in the transforming apparatus can be made while the converter is running. The latter method is commonly used where current is supplied for incandescent lighting and where storage batteries are used.

The voltage applied to a rotary converter can be varied within certain limits, depending on the inductance of the circuits between the converter and the generator, by varying the field excitation of the converter. Usually sufficient inductance is obtained in the transmission circuits and the transformers without the use of choke coils, especially where a frequency of 60 cycles is used. A converter of a given voltage requires a certain amount of magnetic induction through the armature, which is supplied by the field and the armature currents. If the excitation supplied by the series and shunt field windings is stronger than necessary for producing that voltage, a demagnetizing current will flow in the armature which will cause a rise of potential in the outside inductive circuits. If the magnetic induction produced by the field excitation is too weak, a magnetizing current will flow in the armature which will produce an inductive drop in the outside circuits. The action of the converter in respect to leading and lagging currents is the same as that of a synchronous motor. Variation of the field excitation may be accomplished by hand regulation or by the usual series field winding. In the latter case the excitation will vary with the load, and the compounding may be made similar to that applied to direct-current generators.

Rotary converters which are suitably compounded to deliver a constant or increasing voltage with increasing load maintain a practically uniform voltage at the generator terminals, and therefore do not produce the drop in voltage which usually occurs when the generator load increases. This makes it possible to maintain a practically constant voltage on other circuits supplied by the same generator, independent of the variations in the load carried by the converter. Both lighting and railway loads may thereby be supplied by the same generators, independent of the variations in the load on the converter.

In some systems, alternating current is supplied to rotary converters at a distance from the power house, while in others converters are located in the power house with the generators which supply current to them. If a rotary converter located in the generating station is to be compounded to give a rising voltage with increase of load, it is necessary to provide inductance, either in the shape of transformers or in choke coils, between the bus-bars and the converter.

When a rotary converter is supplied with direct current and delivers alternating current, the speed is not held constant, as is the case when the converter receives alternating current, the frequency of which is fixed by the speed of the alternator. When the converter is driven by direct current, its speed, like that of the direct-current motor, is governed by the strength of the field excitation and the voltage of the direct-current supply. The armature reaction also affects the speed, and it is sometimes very high when the converter delivers alternating current. The converter, therefore, is liable to show wide changes of speed when the load changes, and tends to attain an excessive speed unless special means are taken to prevent it.

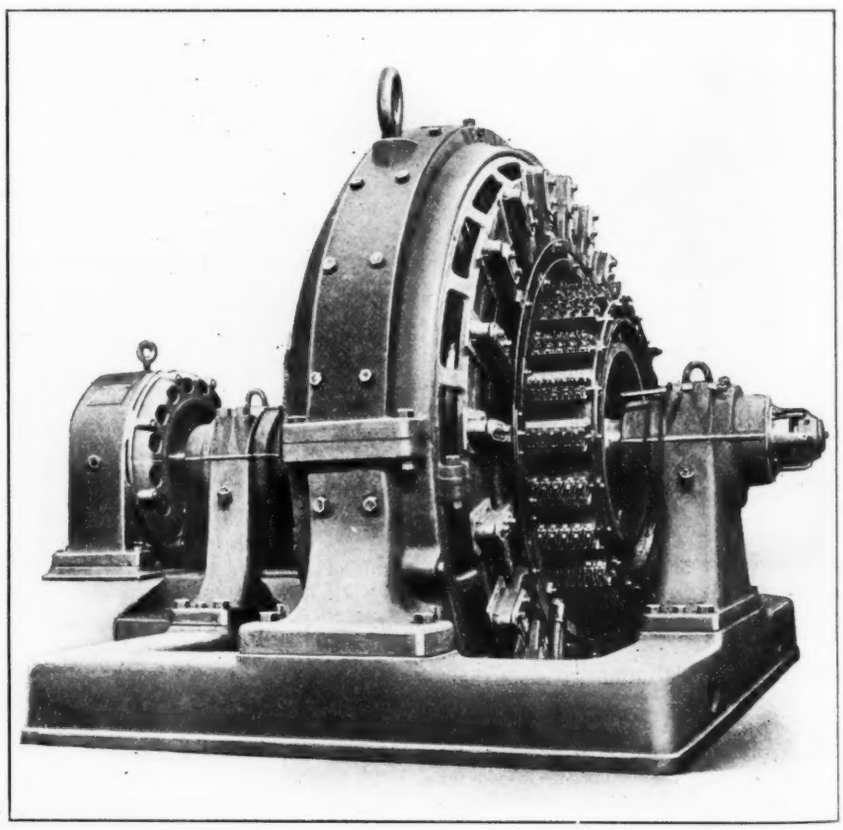


FIG. 10. ROTARY CONVERTER WITH INDUCTION MOTOR FOR STARTING

# Fuel and Boiler Room Economics*

By Prof. C. H. Benjamin

At first sight, the relation between the subject of this paper and that of smoke abatement may seem to be remote. As a matter of fact, it is a very intimate one, since it has been pretty thoroughly demonstrated in the past ten years that boiler-room economy and smokeless chimneys naturally go together. It does not necessarily follow that a smokeless chimney is a sign of economical combustion, but the engineer may rest assured that if he runs his furnaces economically, the top of the stack will take care of itself.

The writer believes that the boiler room has been neglected in the past and more than its share of attention has been paid to the engine. Why owners and engineers should insist so strenuously upon duty tests of engines, and quarrel over a difference of 5 per cent. in steam consumption, or 2 per cent. in regulation, and at the same time allow 15 or 20 per cent. of good B.t.u. to escape up the stack and into the boiler room, is hard to explain. As things go at the present time, it is much easier to effect a considerable saving in fuel by improvement in the boilers, furnaces and chimneys than to improve to the same extent upon the plant in the engine room. It is an old saying that "every dog has his day." Let us hope that the sun has at last risen for the boiler-room end of the proposition.

## Installation of Plant

The economy of the boiler room begins with the installation of the plant. Unless boilers of proper capacity, grates of suitable area and chimneys of suitable size are provided in the first place, no subsequent endeavor will raise the efficiency of that plant above the average. In determining beforehand the type of equipment to be installed, a careful balance should be struck between the first cost and the resulting fixed charges, and the expense for fuel, attendance and repairs. No general rule can be laid down for the solution of this problem, and each engineer must settle it to his own satisfaction. If the plant is to be run continuously for twenty-four hours a day and seven days in the week, the owner can afford to pay fairly heavy interest and maintenance charges for the sake of improved boiler efficiency and diminution of labor account. A first-class water-tube boiler with mechanical stokers, coal-handling apparatus and forced draft may be an expensive investment, if only run sixty hours a week, while on the other hand, the saving of labor and the better fuel economy will more than pay the difference in running expenses for continuous operation. Let us assume, then, that this matter has been carefully thought out beforehand and that the type of plant selected is that best adapted for the local conditions.

## The Purchase of Fuel

The reason for the poor results shown in many boiler rooms is the fact that the engineer and fireman are entirely at the mercy of the coal dealer and are unable to tell twenty-four hours ahead what variety of dirt they will be obliged to burn on the grates. It is not that coal dealers are more dishonest than other men, but that they are in the coal business for money, and if there are no restrictions in the contract and no oversight of the coal supply, they naturally sell everything that they have in the yard without much regard to its heating value. It has even been necessary to bribe the driver of the coal wagon in order to secure fuel which was free from slate and refuse. Owners who buy coal without any safeguards to insure good quality must expect to be treated in this way, with only themselves to thank. I hold no brief for the owner or for the coal dealer, but would always recommend that the same precautions be exercised in buying coal as would prevail in other lines of business. One who buys without scrutinizing, like the victims of the "pig in the poke," can expect little else than the poorest quality of goods.

Coal should not be bought by the ton without some guarantee as to its heating value. The most scientific method of determining this is by chemical analysis or by burning in a calorimeter. If coal is bought from different fields where the chemical composition varies widely, it should always be purchased subject to analysis or calorimeter test. In such cases, a sliding scale of prices can be adopted, the analysis or heat value of the samples submitted with the bid serving as a standard and a certain range of heat variation being allowed. The total range generally adopted is 500 B.t.u. A coal the heating value of which varies more than 250 B.t.u. on either side of the standard, is subject to either penalty or bonus in proportion to the variation. Where the coal purchased all comes from one field and has approximately the same chemical composition, it is often safe to determine the ash content so as to insure the purchaser against an undue proportion of non-combustible material. In such cases, the standard per cent. of ash is determined from the sample and a variation of 2½ per cent. each way from the standard is allowed, a sliding scale of prices being adopted as in the preceding example. A large number of tests of coals from the Indiana and Illinois fields, which have been reported from time to time, warrants the statement that the ash content varies nearly in an inverse ratio to the change of B.t.u.

The coal used in our plants should be weighed on the track at the power plant. It is not to be expected that these weights will tally exactly with those at the mine, on account of the variation in the amount of moisture. All coal, when freshly mined, contains a comparatively large per cent. of water and this varies in different mines. Exposure to the hot sun and to wind will reduce this moisture content, while a heavy rain will increase it. By weighing at the power plant, in case of undue variation from the previous weight an examination of the amount of moisture present would enable the purchaser to be reasonably sure that he was getting what he paid for.

## Burning Fuel

In burning coal under a boiler, it should be remembered that the object is to transfer as much as possible of the total B.t.u. contained in the coal to the water in the boiler, and that any failure to do this shows a lack of engineering ability.

No leak or waste is too small to deserve attention and unceasing vigilance is the price of economy. The grates, if hand-fired, should be of standard shaking pattern and the fire kept thin enough so that it can be kept clean and bright without too much overhead slicing. Every time that the furnace door is opened for the introduction of coal or for cleaning the fire in any way, there is a distinct loss of efficiency on account of the inrush of cold air. Most boiler-room fires suffer from too much meddling. It is undoubtedly better in all plants of any size to install mechanical stokers, there being the double advantage of a uniform feed of fuel and a definite air supply, just sufficient to maintain combustion. When combined with mechanical handling of the coal and ash, there is always a distinct saving in the labor bill.

It is unreasonable to expect the ordinary fireman to care for more than about 200 horse-power of boilers where the furnaces are fired by hand with soft coal. The use of mechanical stokers will at least double his capacity, and when mechanical conveyers are used, one fireman can sometimes tend from 800 to 1000 horse-power. For large plants with a good boiler reserve and a fairly steady load, chain grates are undoubtedly the most successful method of feeding coal. Where the plant is of medium size and the load fluctuates badly, underfeed stokers will probably give better results than hand firing. The principal objection to these latter in larger plants is the inconvenience of removing the clinker through the fire doors into the boiler room.

Whether fired by hand or by machinery, the economical fire is the one which is always bright and clean, free alike from a covering of green fuel and from an under stratum of clinker and ash. The chilling of the flame in too intimate contact with the boiler tubes, with the consequent sluggishness of the fire and deposition of

*Abstract of a paper read at the third convention of the International Association for the Prevention of Smoke, Cleveland, O., June 24, 25 and 26, 1908.

soot on the flues, is one of the most common causes of lack of efficiency. The removal of the fire from immediately under the boiler, on the dutch-oven principle, is the rational solution of this question.

Many firemen do not appreciate the importance of clean flues and the fact that a smoky fire does more damage in this way than by the actual loss of heat from imperfect combustion.

The importance of good draft is frequently not appreciated, and many of the evils of the boiler room, including overheated grates and big repair bills, are due to imperfect circulation of air under and through the grates. There should always be a large excess of draft at hand. It is better to have a chimney 50 feet too high than too low. A powerful draft insures a cool grate and ash-pit, a high rate of combustion and a better transmission of heat from gases to flues. If your chimney temperatures are too high, it means either that the heating surface of the boiler is insufficient for the grate area or that the gas is not baffled enough and has not a high enough velocity in the passages. Better a good draft, a small grate and a high rate of combustion combined with a high velocity of gases over the heating surfaces.

In many boiler rooms there is a considerable loss of heat on account of radiation from the brickwork and from the ash-pit and escape of heat through leaks in the masonry. A small crack will suffice to carry out an appreciable fraction of the heat of the fire.

### General Suggestions

There is a prevalent feeling that the steam boiler at the present day is but on the threshold of its career and that the future will see boilers capable of doing much more work in proportion to their size and the space occupied. Although considerable progress has been made of late in the construction of the boiler itself, as regards increase in heating surface, more efficient circulation and greater steaming capacity, and although the introduction of the mechanical stoker has improved the methods of burning fuel, there is still great room for improvement. It is sometimes dangerous to prophesy as to the future of any mechanical or engineering apparatus. When, however, we compare the comparatively sluggish and illy regulated coal fire of the power plant with the perfect combustion and intense heat of the open-hearth steel furnace, we are justified in predicting an improvement in the former.

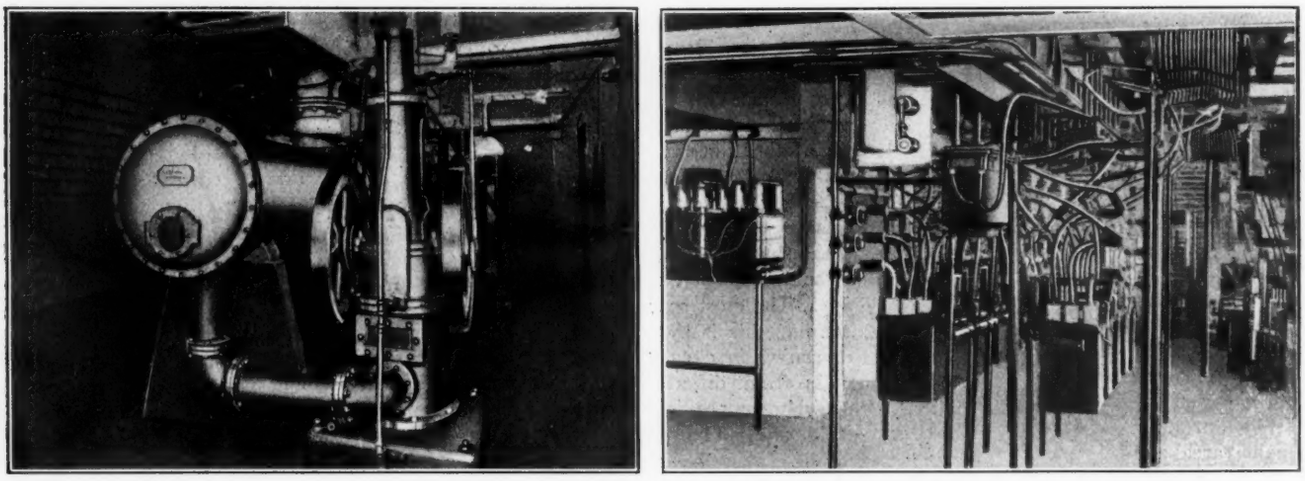
When the coal fire is removed from its inconvenient and uneconomical position under the boiler and the combustion is perfected in a brick-lined reverberatory furnace operated under forced blast with air heated by regenerators, the heat efficiency and the evaporative capacity of steam boilers will be enormously increased. The secret of good combustion in boiler work, as in metallurgy, is complete combustion of the coal in a separate receptacle and the maintaining of gases at a very high temperature before coming in contact with any cooling surface whatsoever.

Experiments by independent investigators have shown that the capacity of a tube for transmitting heat is enormously increased by moving the gases over it with a high velocity. This points to the use of boilers in which the gases are conducted lengthwise of the tubes at a high velocity, passing over successive layers of tubes in series until the temperature of the gases is reduced to the proper point for delivery to the stack. A combination, then, of a reverberatory and regenerative furnace with high-pressure draft, a high velocity of furnace gases and a long series of heating tubes entirely free from soot and scale, points to a higher efficiency and greater capacity. With this will naturally go higher steam pressure and more superheat. Since these last two mean higher temperatures for the escaping gases, the more extensive use of economizers for heating feed water is to be predicted. High temperature, high pressure and high velocity are the three factors which will revolutionize boiler-room practice.

## A Kansas Irrigation Plant

By B. S. Nelson

Near Garden City, Kansas, the United States Reclamation Service and Bureau, under the Department of the Interior, is constructing an irrigation plant known as the Garden City Project, which is intended to convert a large arid district in that section to farm land. During the wet season the Arkansas river has a large flow, while in the dry season it is a brook on the surface, but has a considerable body of water flowing a short distance under the surface of the ground. In the Garden City project a power plant and twenty-three electrically driven pumping stations located along the line of flow of the underground stream are to make available this water for irrigation by pumping it to the surface.



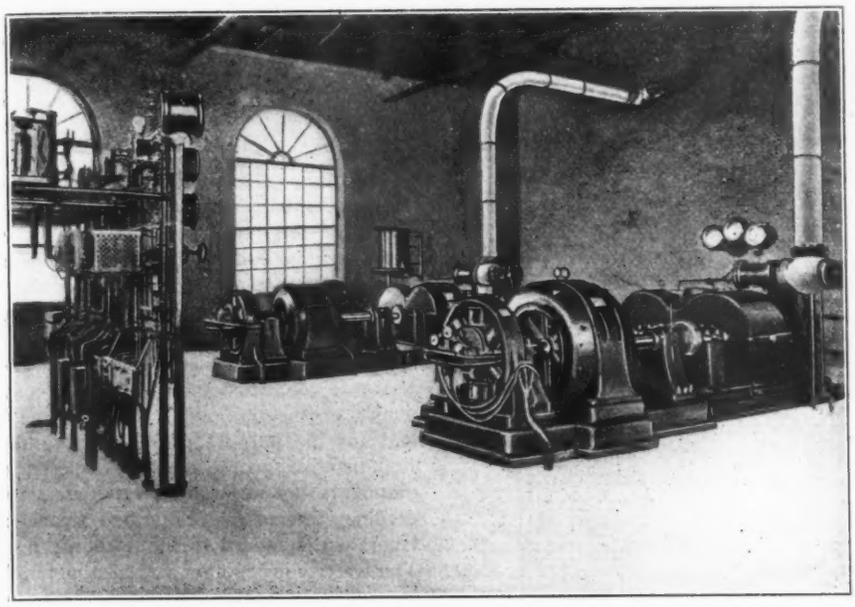
CONDENSERS AND ELECTRICAL CONNECTIONS IN BASEMENT OF GARDEN CITY PLANT

Approximately 10,000 acres will be affected by this project in a strip 20 miles wide. A ditch is arranged called the Farmers' Ditch, with a set of flood gates at its junction with the river, so that when the river level comes to a certain hight it flows into the ditch, feeding the irrigating system. When the river level falls below that needed to feed the ditch, the supply is pumped from the underground stream by the various stations into the canal, the flood gates being closed.

The entire pumping plant is of modern design in all details, having two 200-horse-power Stirling boilers set singly and designed to generate steam at 150 pounds pressure. With each boiler is a superheater giving 120 degrees Fahrenheit above normal boiler temperature. To supply the boilers a narrow-gage track leads from the coal house outside the power station, the coal being brought in two ½-

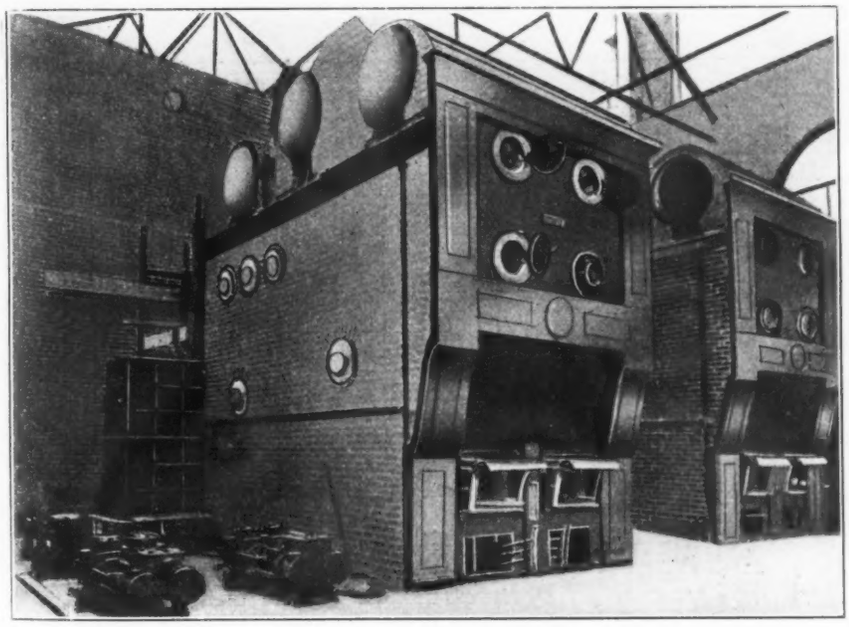
ton cars to the space in front of the boilers and fired by hand. Draft is supplied by a steel stack 150 feet high.

Two turbo-generator units are installed, each of 225 kilowatts capacity, generating three-phase currents at 6600 volts, 60 cycles. Exciting current is taken from a dynamo directly mounted on the end of the generator shaft. These turbines are designed for best efficiency at 150 pounds pressure and 100 degrees superheat, exhausting into 28 inches vacuum.



TURBO-GENERATOR UNITS IN GARDEN CITY PLANT

Two surface condensers are also placed in the basement, furnished by the Wheeler Condenser and Engineering Company, and each fitted with an Edwards vacuum pump. The capacity of each condenser is 5200 pounds of steam per hour, and condenses at an absolute pressure of 1½ inches mercury with cooling water at 165 degrees Fahrenheit.



THE BOILERS IN THE GARDEN CITY PLANT

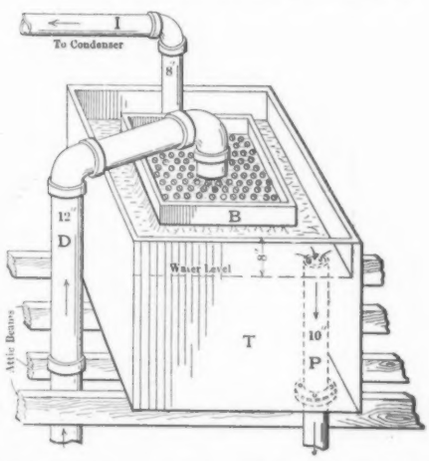
Five marble panels are placed in the switchboard, two for the generators, one for the exciters and two for line service. On generator and line panels are pilot switches which are connected to oil-brake switches mounted in the basement below the switchboard and operated mechanically from the apparatus on the board. Transformers and other apparatus are also installed in the basement, necessitating quite an elaborate system, which had to be installed with the greatest caution.

This installation was made by the D'Olier Engineering Company, of Philadelphia, under the supervision of Charles F. Slichter, supervising engineer, and O. H. Ensign, electrical engineer for the United States Reclamation Service.

## Splashing Tank Cured

By J. O. Frazier

The sketch shows provision for preventing the splashing over of water from a small tank into which a very large pump discharged its water. Our tank was only about 6 feet square and 5 feet deep. There was an 18x18x24-inch circulating pump which delivered its water through the 12-inch pipe *D*. The tank *T* was supported on the beams in the top of the house about 30 feet from the ground, and in a situation which would not permit of any splashing over of the water. The pump ran about 30 strokes per minute, and would deliver not far from 750 gallons per minute, equivalent to a tank full in about 1½ minutes. From the tank the 8-inch injection pipe *I* drew the water to the condenser of the vacuum pan.




ARRANGEMENT TO PREVENT WATER SPLASHING OVER TANK TOP

While putting the apparatus up there had been considerable concern about how the discharge of so heavy a pump into so small a tank would behave. First, the pipe *D*, where it entered the tank, was surmerged much below the surface, but it caused a whirlpool and necessitated some other remedy. The wooden box *B*, about 4 feet square and 6 inches deep, with the bottom bored full of 1-inch auger holes, to allow the easy distribution of the water over a comparatively large area, was tried and succeeded perfectly. It had to be assisted with a covering of bagging over the tank and box top, however. The water-level line in the tank was about 8 inches below the top, and a 10-inch overflow pipe *P* ran from the ground up through the bottom of the tank.

A steam turbine requires 4 square feet of condenser cooling surface per kilowatt.

# Working Results from a Gas Electric Plant

## Report of a Thirty-day Test Conducted at the Gas-power Service Plant of the Richmond (Va.) Works of the American Locomotive Company

BY J. R. BIBBINS

The equipment of the American Locomotive Company's gas-power plant at Richmond, Va., consists of a horizontal, tandem gas engine, direct-connected to a direct-current generator and operating on gas generated by a pair of 9-foot (shells) bituminous producers. The gas is purified by means of wooden-slat scrubbers and a centrifugal tar extractor, motor-driven. A 15,000-cubic-foot holder serves to equalize its quality and to start the engine, which is necessary to bring the motor-driven auxiliaries into service. The engine is of the modern double-acting type, with cylinders 23½ inches in diameter and 33 inches stroke, and is governed by a sensitive oil-relay system designed to relieve the governor of all valve work. Regulation being by the constant quality method, the ratio of air to gas is constant except when the gas itself changes, for which event hand-regulating dampers are provided. An important feature of the producer is that it is designed for continuous operation, having a water-sealed bottom instead of a closed ash pit, to permit the removal of ash at any time. It generates its own steam, requiring no auxiliary boilers, so that the only auxiliaries required for the entire plant are a motor-driven fan, tar extractor, and igniter set. In the aggregate these auxiliaries absorb about 5 per cent. of the station capacity.

The Richmond works employ motor-drives to a considerable extent, and for such diversified purposes that the individual demands superpose to a large degree and yield a fairly constant total.

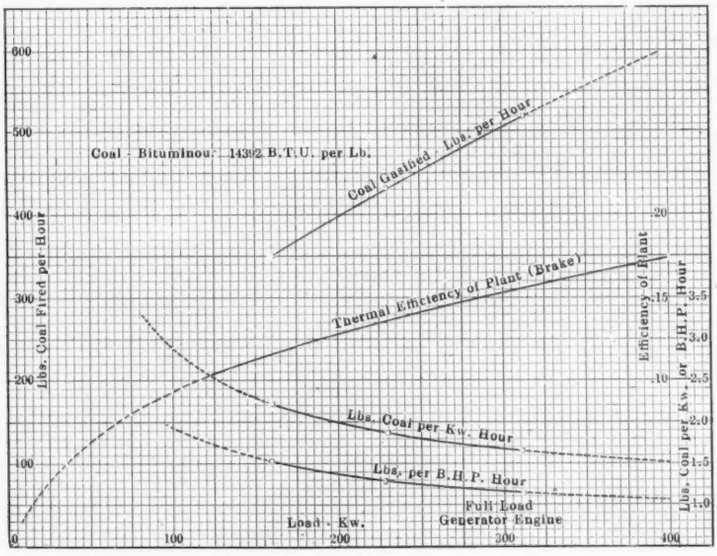

Coal - Bituminous - 14382 B.T.U. per Lb.
Coal Gasified - Lbs. per Hour
Thermal Efficiency of Plant (Brake)
Lbs. Coal per Kw. Hour
Lbs. per B.H.P. Hour
Full Load Generator Engine
Load - Kw.
Lbs. Coal Fired per Hour
Efficiency of Plant
Lbs. Coal per Kw. or B.H.P. Hour

FIG. 1. GAS-POWER PLANT ECONOMY AT VARIOUS LOADS

Constituting the main service plant of the Richmond works, the gas-power equipment is called upon for continuous 24-hour service, except on Sundays and holidays.

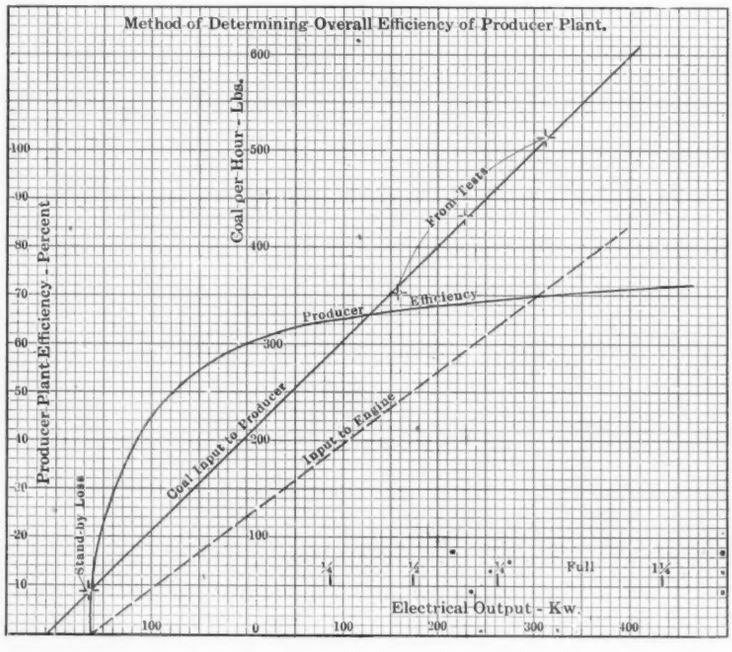



FIG. 2. GRAPHICAL METHOD OF DETERMINING OVER-ALL EFFICIENCY OF PRODUCER PLANT

### The Test

The test was continued for practically four weeks, half of the time on a full-load run and the remaining two weeks on three-fourths and one-half load, respectively, with a rate of gasification of 0.25 ton per hour. A continuous run of 223 hours' duration evidently provides an excellent guarantee of accurate results. The test was conducted entirely by the company's engineering and operating staff, and for the purpose of determining the fulfilment of guarantees. The electrical output was measured by direct-current recording wattmeters calibrated from a laboratory standard previous to the test. The water consumption was also metered, no great accuracy being desired. The coal was weighed by scales checked from time to time by standard weights. Samples from such weightings, accumulated during a day's run, were quartered down and sealed for analysis (Table 1).

It should be noted that at full load, 312 kilowatts, the engine was running somewhat below full rating, but the true full-load coal consumption may readily be found. For this purpose, these data have been plotted in Fig. 1 in the form of three related curves: (a) Rate of gasification in pounds per hour; (b) pounds per unit of output per hour, and (c) correspond-

ing thermal efficiency. The first-mentioned curve is important in all analyses of steam or gas engines to determine the rationality of the results, for the line of heat input to the engine as well as to the producer should be practically straight, as

TABLE 1. GENERAL RESULTS OF TEST.

| | Full Load. | Three-Quarters Load. | One-Half Load. |
|---|---|---|---|
| Length of run, hours | 223 | 125 | 136 |
| Average load, kilowatts | 312.3 | 228.3 | 159.6 |
| Average load, computed boiler horse-power | 455.0 | 333.0 | 238.0 |
| Load, per cent. engine rating | 91.0 | 67.6 | 47.5 |
| Load, per cent. generator rating | 104.0 | 77.2 | 53.2 |
| Coal gasified, pounds | 115,289 | 54,143 | 47,775 |
| Coal gasified per hour | 517.0 | 433.0 | 351.0 |
| Output, kilowatt-hour | 69,650 | 28,540 | 21,710 |
| Pounds coal per kilowatt-hour | 1.654 | 1.697 | 2.20 |
| Pounds coal per kilowatt-hour, guaranteed | 1.93 | 2.10 | 2.64 |
| Pounds coal per boiler horse-power-hour | 1.14 | 1.31 | 1.56 |
| Average heat value of coal, B.t.u | 14,392 | 14,392 | 14,392 |
| B.t.u. per kilowatt-hour | 23,700 | 27,280 | 31,650 |
| B.t.u. per boiler horse-power-hour | 16,415 | 18,710 | 21,670 |
| Per cent. thermal efficiency, brake | 15.51 | 13.6 | 11.75 |
| Per cent. thermal efficiency, electric | 14.35 | 12.65 | 10.78 |

Coal—Pocohontas Run-of-mine; average heat value dry sample, 14,703, as fired, 14,392; volatile matter, 22.8 per cent., ash 4.5 per cent., sulphur 1 per cent.
Test—August 12, 7 a.m., to September 7, 12 m.

developed during the test of a similar engine at the works of the Norton Company. The second curve, showing the relative fuel economy at various loads, necessarily follows the form of an equilateral hyperbola, being derived from the line of total coal input. Finally, the third curve, efficiency, represents that part of the heat in the coal that has been converted into useful work. This is absolute or kinetic efficiency, and not akin to the "efficiency ratio" employed in steam-engine practice. It covers all losses between coal pile and switchboard.* It is found that the gross coal consumption of the plant at full engine load is 550 pounds per hour, or 1.59 pounds per kilowatt-hour, equivalent to approximately 1.09 pounds per brake horse-power-hour. And with a 400-kilowatt load, which is easily within the limits of this particular plant, the coal consumption would be roughly 1.5 pounds per kilowatt-hour, or one pound per brake horse-power-hour.

This characteristic of constantly increasing economy by the gas-engine plant up to the point of maximum load illustrates an essential difference from steam-engine economy which usually is best at loads 70 to 80 per cent. rating, according to the cylinder ratios employed. By projecting backward the line of total coal gasified, we find that it requires over one-third of the full-load coal to run the plant unloaded. This represents a standing charge against its operation, becoming less and less important as the load increases.

During the four weeks' test there were several days during which the plant was allowed to stand idle, as the works are not operated Sundays. During this period, some coal was required to keep the producer fires at their normal level and in good condition. It would, of course, have been possible to starve the fires during standby periods, but this would simply have resulted in a higher coal consumption during the succeeding run. According to the judgment of the producer operator, an average of 1700 pounds of coal were required to compensate for standby losses from 6 p.m. Saturday until 7 a.m. Monday, a period of 37 hours.

Fig. 2 shows a graphical method of determining the producer-plant efficiency. Here are plotted three economy tests and the standby loss. Not knowing the heat input to the engine at various loads by actual test, the guaranteed efficiencies have been plotted extending the line backward to a point of zero input. This corresponds to 166 kilowatts total losses in the engine unit. Assuming that the producer is maintained ready for operation, there are four points to determine the curve of producer input. And the ratio between engine and plant output gives directly the gross efficiency of the gas-

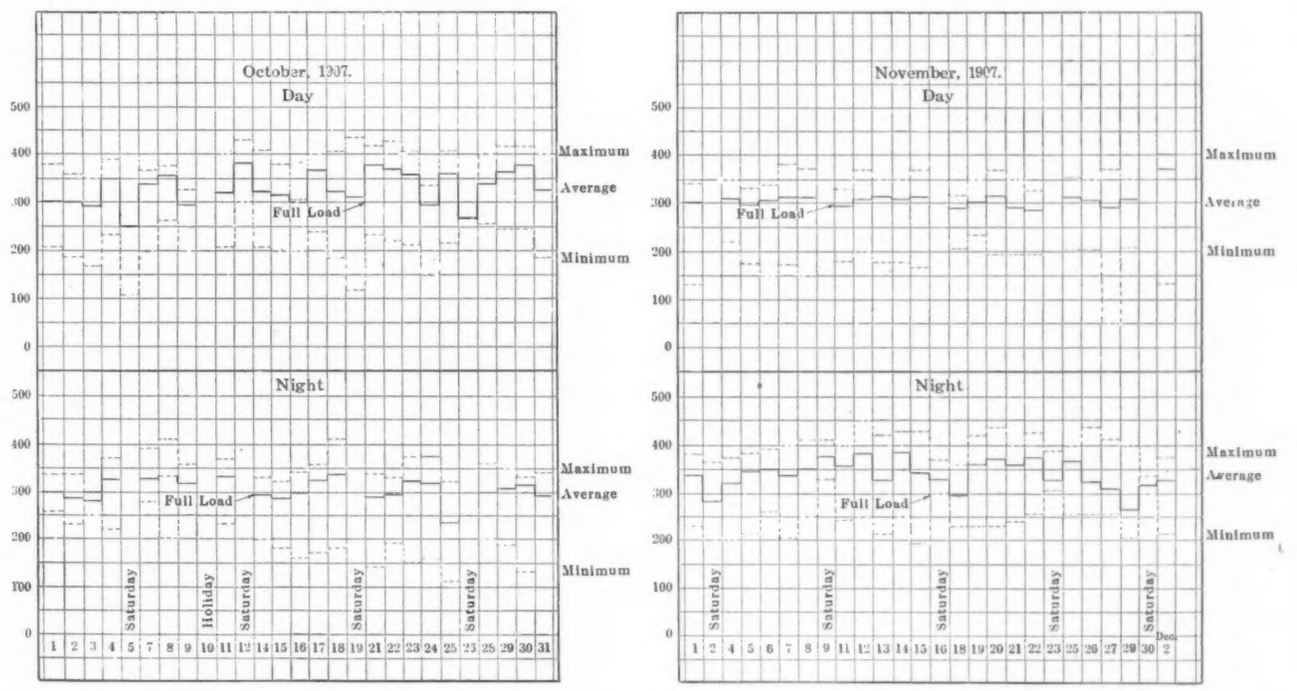



FIG. 3. ELECTRICAL LOG FOR TWO MONTHS, SHOWING AVERAGE MAXIMUM AND MINIMUM LOADS CARRIED

*Taking the mechanical equivalent of heat as 778 B.t.u., the thermal value of one horse-power-hour is 2545 B.t.u., and that of a kilowatt-hour 3412 B.t.u. Hence, absolute thermal efficiency equals 2545 ÷ B.t.u. per brake horse-power-hour, or upon an electrical basis, 3412 ÷ B.t.u. per kilowatt-hour.

TABLE 2. COST OF POWER, 700-KILOWATT GAS-POWER PLANT.

ASSUMPTIONS.

| | |
|---|---|
| Equipment cost: | |
| Building and machinery | $96.60 |
| Cost per kilowatt, $138; per boiler horse-power, $96.60. | |
| Fixed charges: | |
| Interest 5 per cent, taxes and insurance 1.5 per cent., depreciation (sinking fund 15 years 5 per cent.), 4.63 per cent., running repairs 1.5 per cent. on investment. Total 12.63 per cent. per year | 12,220 |
| Operation: | |
| 300 days, 7200 hours per year, 5,040,000 kilowatt-hours. | |
| Input to auxiliaries, 5.4 per cent, full 10.8 per cent. half-load. | |
| Standby losses, producer plant, 1600 pounds per week, 2.1 per cent. full, 3 1 per cent. half-load. | |
| Fuel rate, full load, 1.59 pounds + 2.1 per cent. = 1.62 pounds per kilowatt-hour; ½-load 2.1 pounds + 3.1 per cent. = 2.17 pounds per kilowatt-hour. | |

COST OF POWER, 700-KILOWATT TURBINE PLANT.

ASSUMPTIONS.

| | |
|---|---|
| Equipment: | |
| Building and machinery, $100 per kilowatt | $70,000 |
| Fixed charges: | |
| Interest 5 per cent., taxes and insurance 1.5 per cent.; depreciation (sinking fund 16⅔ years at 5 per cent.) 4 per cent.; repairs 1 per cent., total 11.5 per cent | 8,050 |
| Operation: | |
| 300-day year, 7200 hours. | |
| Average water rate, full-load 21.5 pounds per kilowatt-hour. | |
| Average water rate, one-half load 25.5 pounds per kilowatt-hour. | |
| Gross evaporation, 7.5 to 8.0 pounds. | |
| Standby, banking, 10 to 15 per cent. | |
| Gross coal consumption, full, 2.96 pounds per kilowatt-hour; half, 3.9 pounds per kilowatt hour. | |
| Wages and supplies—Same as gas. | |

generating plant from coal pile to engine throttle.

A careful measure of oil consumption was made during the two weeks' run at full load, comprising 223 hours' operation, also the water consumption of the engine. During this period, the average rate of cylinder-oil consumption was 0.09 gallon per hour, or, on the basis of a ten-hour working day, 4.9 gallons per week. This confirms to a considerable degree, the experience at the Norton works, where an engine of the same size uses 3.5 to 4 gallons per week (ten-hour day). The high economy of oil is due to the system of timed, forced circulation employed.

The average quantity of cooling water used was 6.56 gallons per brake horse-power-hour at heavy load with inlet temperature varying from 75 to 80 degrees Fahrenheit and outlet from 140 to 150 degrees Fahrenheit. This quantity is quite reasonable for the temperature rise.

TABLE 3. COST PER KILOWATT-HOUR AND HORSE-POWER-YEAR, GAS PLANT.

| COST ITEMS. | | | FULL LOAD. | HALF LOAD. |
|---|---|---|---|---|
| | | | Cents per kw.-hr | |
| Coal | at | $1.00 | 0.081 | 0.109 |
| | | 2.00 | 0.162 | 0.217 |
| | | 4.00 | 0.324 | 0.434 |
| | | 6.00 | 0.486 | 0.651 |
| Wages | per year, | $6,160 | 0.121 | 0.242 |
| Supplies | " | 3,850 | 0.076 | 0.143 |
| Fixed charges | " | 12,200 | 0.242 | 0.484 |
| Total costs—coal at $1.00 | | | 0.520 | 0.978 |
| 2.00 | | | 0.601 | 1.086 |
| Richmond coal...$2.70 | | | 0.658 | 1.163 |
| 4.00 | | | 0.763 | 1.303 |
| 6.00 | | | 0.925 | 1.520 |
| | | | Dollars per Electric H.P.-year. | |
| Equivalent power rate: | | | | |
| 300-day year, coal at $1.00 | | | $27.90 | $52.40 |
| 2.00 | | | 32.30 | 58.20 |
| 2.70 | | | 35.60 | 62.40 |
| 4.00 | | | 41.00 | 69.90 |
| 6.00 | | | 49.60 | 81.50 |
| Charges for auxiliaries if motor-driven | | | 2.7% | 7.4% |
| Saving, gas over steam: | | | | |
| Coal at | $1.00 | —3% | —8.5% | loss |
| | 2.00 | +8% gain | +0.9% | gain |
| | 2.70 | 12.9% " | 4.7% | " |
| | 4.00 | 19.6% " | 12.4% | " |
| | 6.00 | 33.7% " | 19.0% | " |

## OPERATING RESULTS

It seems to be the general impression that a gas-power plant must be handled gingerly in order to obtain good results. The accompanying operating data from Richmond should dispel this impression. Fig. 3 shows typical results for two months' operation, representing an output somewhat below normal. It is worth while to note the continuous operation throughout the week, 24 hours per day, and particularly the high average load sustained. The normal run at Richmond is six days without stopping. In fact, the producer fires remained undisturbed from July 4, 1907, until early in the present year, when an opportunity occurred to make careful inspection of the entire equipment.

The plant has sustained a load of 410 kilowatts for three hours, and even higher

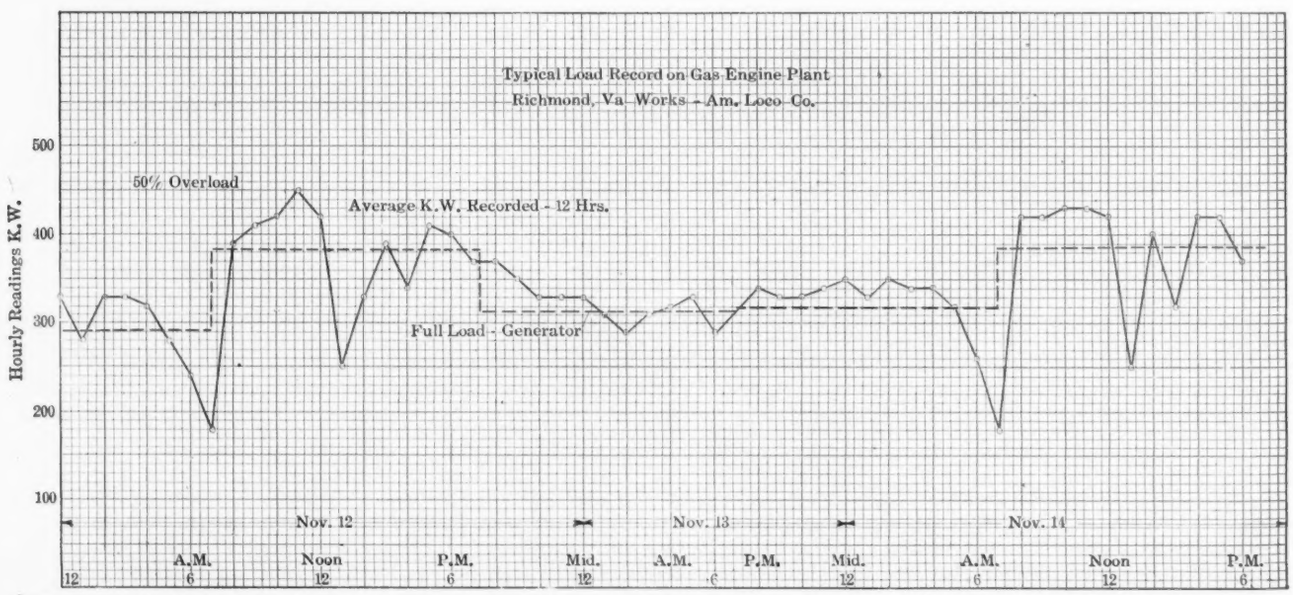



FIG. 4. TYPICAL HOURLY LOAD RECORD, SHOWING OVERLOAD CAPACITY OF PLANT

overloads for short periods, as indicated in Fig. 4.

### Operating Costs

Owing to the fact that the present power plant was made to accommodate a two-unit plant, the cost has been computed upon this basis, and in view of the excellent results that have been obtained, the electrical rating of the plant has been placed at 700 kilowatts, or 1000 horsepower, at which rating the investment cost becomes about $138 per kilowatt, or $96 per brake horse-power, complete, including machinery, buildings, foundation, piping, erection—in fact all items except the value of the land occupied. Considering the limited size of the plant, this does not represent an excessive cost, which in large plants would probably be as low as $100 to $125 per kilowatt.

In this total cost of power are included the usual fixed charges—interest at 5 per cent., taxes and insurance 1.5 per cent. In the absence of any data on repairs (there having been none on the engine up to the present time, and very small repairs on generator and producer), this item has for convenience been included in the fixed charges at 1.5 per cent. on the plant investment. Further, depreciation has been included in the form of a sinking fund, based upon 15 years' life of plant at 5 per cent. interest. This latter method may be contrary to general practice, but considering the nature of the depreciation fund and its earning capacity, the annuity method seems most logical.

These costs are shown in Table 3. Based on 300-day operation, 7200 hours per year, the fixed costs are distributed only over the operating period, not over the entire year. And, assuming the price of coal largely determined by location, the efficiencies at various loads are considered constant, irrespective of the price of coal. Both standby losses and power-consumption charges have been included. As we are considering an industrial plant in which the load averages practically uniform throughout the day, it suffices to estimate power costs at full and half loads respectively. This has been done in Table 3 for various coal prices. Coal prices are based upon net ton.

The results show that at the price of fuel at Richmond, $2.70, power can be delivered at switchboard at a cost of two-thirds of a cent per kilowatt-hour for a fully loaded plant operating 7200 hours per year, or less than 1.25 cents operating at half-load, taking into account fixed charges which range around 40 per cent. of the total cost. Even with coal as high as $6 per ton, the total cost of power would be under one cent per kilowatt-hour, obviously an excellent result.

[The foregoing is an abstract of a paper read at the annual convention of the American Institute of Electrical Engineers, June 29-July 2, 1908.]

## Give the Plant a Fair Chance

By G. F. Nistle

Much is heard about giving "the boys" a fair chance, and boast is made of our Anglo-Saxon love for fair play, but we are prone to think that fair play is something only affecting human beings and possibly fighting dogs. Our thinking thus does not make it true, nor does it excuse the indolence that forbids the study of mechanical problems relating to a plant.

Engineers are sometimes guilty of the indolence referred to, and in designing a power station will often accept conditions that are unfavorable to the building of a really good plant, blaming the architect for producing such conditions. The architect may be very much to blame, but the conditions might often be improved with very little expense if the engineer would only study the problem long enough to find out what conditions nature had imposed before the architect took hold.

Although the engineer is sometimes guilty of injustice to the plant and the architect, still the greatest sinner is more frequently the owner. He employs an architect to design a building, sometimes gets an engineer to design a power plant for it, pays all the bills promptly and then starts in on a career of neglect and deprivation that soon makes the new plant look like a junk pile.

An example of how the owner failed to give the power plant a fair chance will be found in the following case: A well-known architect had designed and built a skyscraper with a basement only 8 feet deep, and the owner had contracted for a power plant much smaller than it should have been, the contract being based on a price as much too small as the plant itself. In order to erect boilers of stock design in the limited hight, the grates were placed at floor level and a smoke passage, not a combustion chamber, was excavated behind each bridge wall. Much of the time this was full of water, and with the sulphurous coal burned produced a vapor containing sulphurous acid to attack the iron in the boilers, while the evaporation of the water made an enormous coal bill.

An engine of cheap construction was installed to run two dynamos for lighting. A big, hungry elevator pump, a boiler feed-pump and a house pump completed the plant. After a short time everything began to get out of order and a new man took charge every few weeks. At last the building was sold and the new owner put in what was considered an up-to-date plant—water-tube boilers, a new single-cylinder engine for lights, a new house pump and a compound engine, also a compound elevator pump. For some time everything went well, then trouble began. The dynamo attached to the simple engine began to break down and always at a time when the compound engine was being repaired.

### The Engineer Wrongly Blamed

Finally, on a dark afternoon, the compound engine had to be stopped on account of a hot bearing. The small engine could not carry all the load, or rather its dynamo could not, so a large part of the building was dark. The engineer was blamed for the failure, but wrongly, for the following reasons: The owner had been repeatedly advised to so arrange his forces that an engineer would be in the engine room during every storm, even if one came every day. When the compound engine was installed he was particularly asked to have someone in the room with the engine to keep it oiled. This was not done, and the engine, not being self-oiling, ran dry and acquired a hot box. Further than this the owner had been requested to get a dynamo of larger size for the simple engine, but would not, preferring to use a machine that he had in another plant.

When the compound engine broke down the crew worked all night to get the dynamo from the simple engine out of the way and the big one in its place, so that the service was saved from further disgrace, but at the cost of an engine loaded beyond the possibility of true economy.

Such treatment is not fair play to the plant, but in the same building occurred another instance showing equally great neglect of the courteous treatment due to respectable machinery. In this case the victim was the compound elevator pump, and its abuse came about in this way: The regular engineer took a much-needed vacation, and while he was away the owner installed a crew of alleged engineers who began to "do things" at once. They wanted to show how good the coal was and how bad was everything else. The second day after they took charge the compound pump "went lame" very quietly and immediately the elevator pressure dropped. Car speed could not be maintained, so an auxiliary pump was started. Still the pressure was below normal and the large elevator pump had to be put to work.

At this stage the writer was sent for and began a systematic test of the pump. The trouble was soon located in the steam chest, where the valve was found riding with one side about ¾ inch above the seat and providing a very free passage between the steam inlet and the exhaust.

How did it get up there? The only proper excuse for such a position of the valve would be the starting up of the pump with the cylinder drips closed and the cylinders full of water, this water being trapped in the space intended for a steam cushion was forced up under the valve, which was thereby lifted from its seat and catching on the guide rib, had to stay up.

# Practical Letters from Practical Men

**Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other**

## WE PAY FOR USEFUL IDEAS

### Making Pipe Joints Below the Water Line

Laying pipe in or under water is not at all uncommon, and very likely the same methods used by the writer in this case are old to others. But as I had never been called on to handle a similar case, it was necessary for me to work out the problem as necessity demanded.

At a time of unusually low water I put in the intake box and screen and several lengths of pipe. The pipe was cast-iron bell and spigot, 14 inches in diameter, to be used as a suction pipe. We used a coffer dam to enable us to put in what was then below the water line. After laying several lengths of pipe and getting well above the level of the coffer dam, a sudden rise of the river covered the pipe dam and all with about 4 feet of water. After waiting some time for the water to fall sufficiently to enable us to get to the pipe the following plan was adopted:

We built a dam across the ditch below the upper end of the pipe. Then, as there was no stop valve on the line, it was necessary to plug the pipe. We made a gromet or ring of an old piece of steam hose. The ends were held together by a wooden plug, fitted tight and nailed in. The joint was then well taped. This ring was made to fit easily into the pipe. To prevent the ring slipping too far into the pipe we fastened it to an iron ring with wires. The iron ring fitted inside the bell of the pipe. We found it necessary to fasten it in eight places as shown in Fig. 2. More fastenings would have been better.

The plug was made of a piece of a cedar pole built up with narrow strips until it was almost the diameter of the inside of the pipe at the large end and tapered enough to enter the hose ring easily. In this case the plug was nearly 2 feet long. We first tried to insert the whole thing at once, but were not successful, and were obliged to make a form out of 1-inch boards to place the rings in position first. We worked entirely with poles, as it was midwinter. The operation of wedging the plug into place is very clearly shown in Fig. 1. After getting the water pumped down we used a jack-screw to force the plug firmly into place. To prevent any possible loosening of the plug and also to enable us to remove it when ready we fastened a long pole to it with iron straps and lag-screws, and kept the pole securely blocked.

We slipped the pipe sections over the pole, one at a time, and after getting three lengths in place we made the two upper joints, letting the leakage from the plug run out at the lower joint. The lower joint was made as follows: The first strand of oakum was soaked in hot beef suet, and when calked in place did not leak a drop. This was followed with dry oakum, and just before pouring the lead we poured in a little kerosene oil. The job was entirely successful.

Before placing the pipe in position we had cut the wires connecting the iron ring and the hose, and had removed the iron ring. We then wired the hose to the plug with a long wire so that when we pulled the plug we got everything that was in there. The three lengths took us about the water line.

A. G. KNIGHT.

La Salle, Ill.

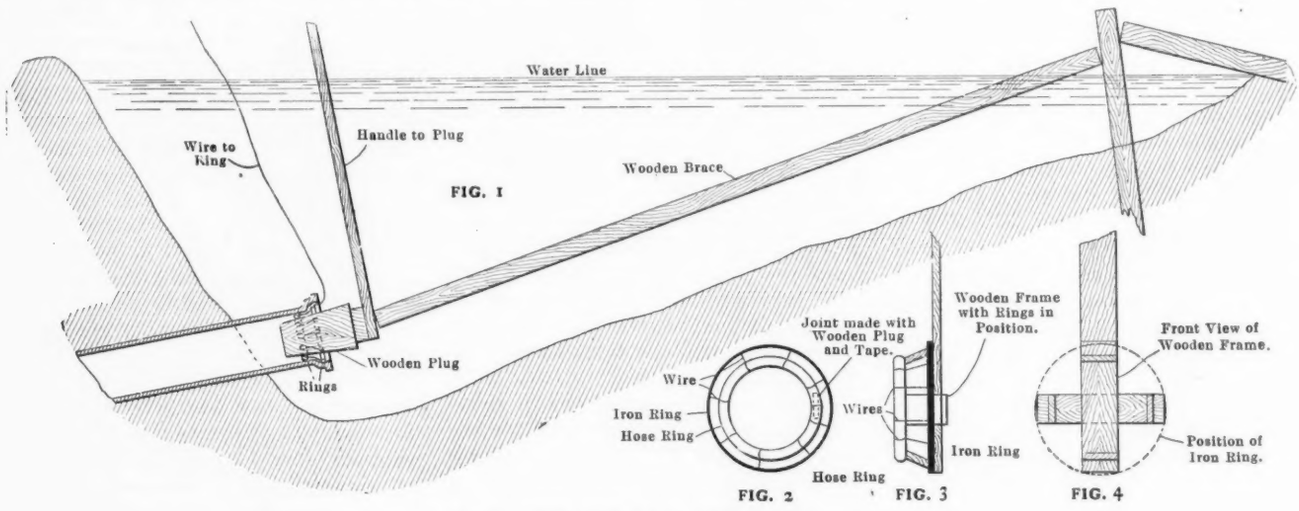



FIG. 1 FIG. 2 FIG. 3 FIG. 4

MAKING PIPE JOINTS BELOW THE WATER LINE

### Rotary Converter Trouble

Replying to F. M. Swaln, Jenison, Mich., relative to the inquiry on rotary-converter trouble as described in the June 16 number of POWER AND THE ENGINEER, I think that the trouble was caused by a sudden and extra pull from the direct-current side of the rotary, caused possibly by a ground on some circuit. This sudden increase in amperage caused the machine to flash over and damage the commutator. This machine may possibly have been run for half a day at its rated load or more and with a poor power factor, which would cause excessive heating of the armature conductor, and when the trouble occurred the excess amperage would raise the temperature above the melting point of the solder. The burning of the middle collector ring was caused by poor contact of the brushes under heavy load, and the fact that the ring was burned badly at six equidistant points was due to the machine having six poles.

H. W. RICHARDSON.

Brockton, Mass.

## New Blow-off Arrangement

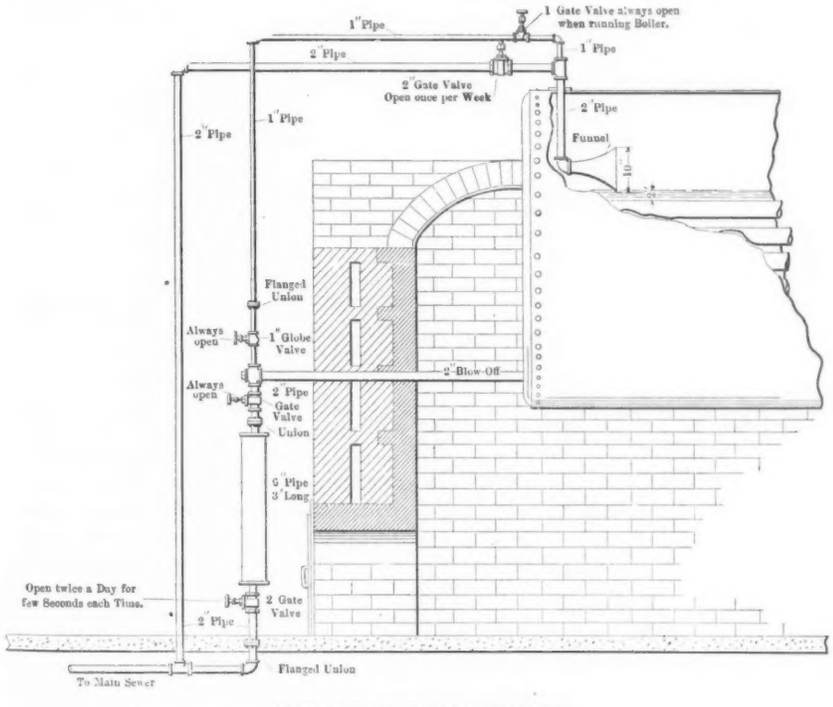
Herewith is a sketch of a new blow-off arrangement. Beginning at the boiler, I have a copper funnel 10 inches in diameter on the large end, and a 2-inch pipe nipple brazed on the small end, screwed in a 2-inch elbow and passing through top of the boiler to a 2-inch tee. This funnel is placed with a clearance of about 2 inches from the top row of flues, with the open end toward the front end of the boiler. The ell to which it is fastened is about 6 inches from the rear head of the boiler. The side opening of the tee above the boiler continues as 2-inch pipe to the main line to the sewer. This line is my surface blower and used only once a week, usually on Sundays, when the steam pressure is reduced to 40 or 50 pounds.

When using this blow-off I begin with about three gages of water and blow down to one gage, this usually being sufficient to take all the surface impurities from the boiler.

Beginning at the 2-inch tee above the boiler, the top opening is reduced to 1 inch and continues to the rear of the boiler, then down outside the rear wall to a 2-inch cross, one side opening of which leads, 2 inches in size, to the boiler, as close to the bottom as possible, this being the blow-off pipe.

The 1-inch line is the circulation line to keep up a constant circulation in the 2-inch blow-off from the boiler. It has suitable valves and unions to allow of easy disconnection. The 2-inch pipe is continued to a piece of 6-inch pipe, 3 feet long, bushed on both ends to 2 inches, a gate-valve being placed above and below the 6-inch pipe and a 2-inch flange union between the upper gate-valve and the 6-inch pipe, and below the lower gate-valve. This enables me to remove the 6-inch pipe at any time during the running of the boilers should it be necessary. The 2-inch pipe is continued from here to the main line to the sewer connection with the 2-inch surface line at or below the floor level, thus using only one line to the sewer for both blow-offs.

During the running of the boilers, both 1-inch valves and the 2-inch gate above the 6-inch pipe are kept constantly open, thus creating a circulation in the 2-inch line from the rear of the boiler (blow-off), and keeping it from plugging up, while the lower gate-valve is kept closed, thus making a dirt or sediment catcher of the 6-inch pipe. I open this lower valve twice a day, a few seconds each time only, leaving the upper valves open on this line, and blow out whatever dirt has accumulated during that time. In this way I can remove a quantity of sediment that otherwise would remain in the boilers until they were cleaned.



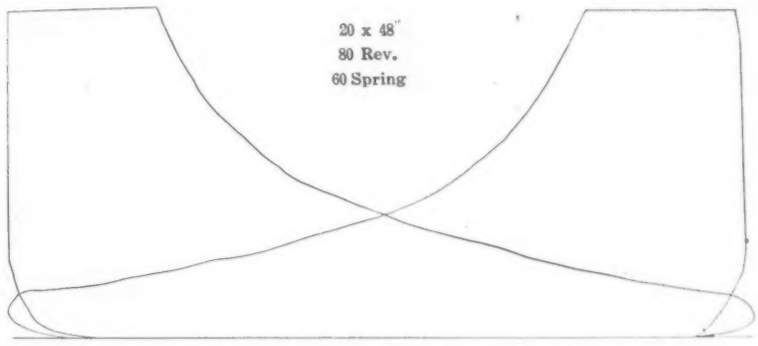

NEW BLOW-OFF ARRANGEMENT

J. BARRHO.

Port Allegany, Penn.

## What Causes the Pound in the Engine?

Having tried without success all the means that I have at hand, I would like the advice of other engineers to assist me to find the cause of a "pound" in a George H. Corliss engine that I have charge of. The engine is about 15 years old and has performed its functions faithfully, its one fault being a solid, disagreeable "pound," as the crosshead leaves the head center, that so far has defied the efforts of all the engineers who preceded me and the "experts" who have been called in to remove it or to locate the cause.




WHAT CAUSES THE POUND?

The engine is a 20x48-inch simple high-pressure machine, turning 80 revolutions per minute. Various changes have been made in the valve setting, the cylinder and valve chambers have been rebored, new piston and rod, new shaft, new disk crank, lining and leveling have all been tried without attaining the desired result.

The apparent effect of the "pound" is to break the taking-up quarter-box at the main bearing, four of them having broken, at the place shown in the cut, during the past four years, the last one breaking after a ½-inch steel plate had been placed between the quarter-box and the taking-up bolts.

WILLIAM MCCANN.

Lynn, Mass.

## Burning Sawdust

The writer has used both the dutch-oven and standard furnace settings for burning sawdust, so he feels competent to write on the subject. I do not think there is anything to beat the dutch oven for sawdust and slabs. The sawdust burns from the top and sides and when it gets warmed up you can burn all the fuel, fill the furnace with green dust, and have

a good fire in two minutes, which means something in a sawmill. With a plain setting, if the feed stops for a few minutes, or the fires burn low, the fireman has to jump around some. I have never seen dust burn from the top of the pile down, except on starting up, but after it gets started it will be hot all through by reason of the fire getting covered up by fresh fuel. They all use automatic feed here.

In all plain furnaces the dust is carried over the boilers and dropped on the sides of the water through chutes on the top. Generally two boilers are placed in one setting. We have four boilers arranged in two patterns.

FRANK REED.

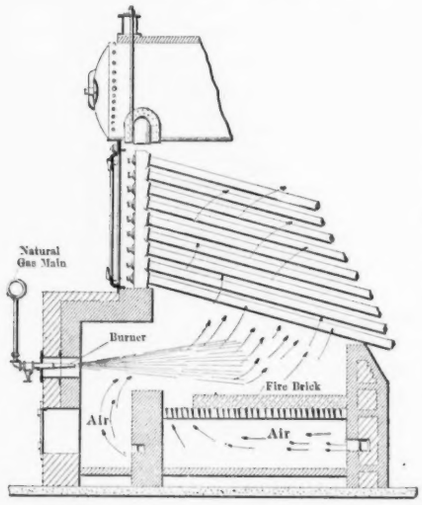
Edna, La.

## A Natural Gas Burner Wanted

In reply to the letter entitled as above in a recent number of POWER AND THE ENGINEER, I would say that it is good and common practice to use an ordinary piece of pipe, or, better, several pipes, for natural-gas firing under steam boilers. The flame from the burner should not strike the boiler directly, as the heat from natural gas is very intense and destructive to boiler tubes and plates. As shown in the accompanying sketch, a combustion chamber is usually built in front of the grate with means for regulating the amount of air and gas supply.

Practically one pound of good bituminous coal is equivalent to 13½ cubic feet of natural gas. The heat of combustion of 1 cubic foot of natural gas is usually slightly above 1000 B.t.u., while the heat obtained from 1 pound of good bituminous coal is somewhere near 13,000 B.t.u.

The quantity of gas resulting from burning 1 pound of coal in air is about 136 cubic feet at atmospheric pressure and 60 degrees Fahrenheit, while 1 cubic foot of natural gas, containing about 93 per cent. of marsh gas ($CH_4$) requires 9.52 cubic feet of air per combustion, making the total quantity of gas burned equal 10.52 cubic feet under similar bases.




NATURAL-GAS-FIRED WATER-TUBE BOILER

As noted before, about 13½ cubic feet of natural gas is required in order to produce the same quantity of heat as a pound of coal. Comparatively, this gives 13.5 × 13.5 = 142 cubic feet of waste gas from natural-gas firing, as against 136 cubic feet with coal firing.

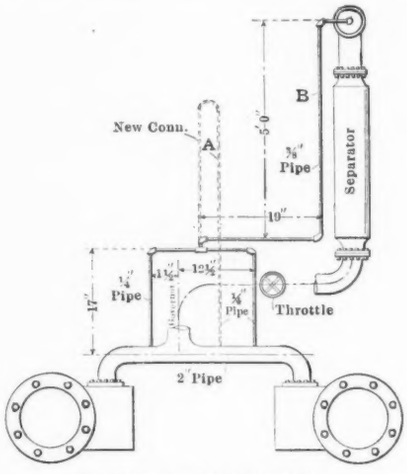
Both values, based on 60 degrees Fahrenheit and atmospheric pressure, differ slightly, and under ordinary conditions the size of stack required would practically be the same for both coal and natural-gas firing. A stack about 80 feet in hight and 3 feet 6 inches in diameter is considered ample for two 100-horse-power boilers.

ULRICH PETERS.

Pittsburg, Penn.

## Lubricator Connections

Herewith is submitted a possible remedy for the troublesome lubricators shown and described by H. B. Lawson in a recent number. I have assumed that the govenors and throttle are located as per this sketch. If so, his condenser pipe is connected at a point where the steam pressure is reasonably constant and, if the piping is good, will be equal to boiler pressure—say 100 pounds—while the lubricator connections are made below the governors at a point where the steam pressure will vary greatly, dependent on the work required of the engine. However steady the load on the compressors may be the steam pressure in the pipe below the governors will rise and fall with the opening and closing of the steam ports, and the average pressure here may not be over 50 pounds, while with a heavy load it may run up to 80 pounds. This difference between the inlet and outlet to the lubricator will cause an uneven feed.




LUBRICATOR CONNECTIONS

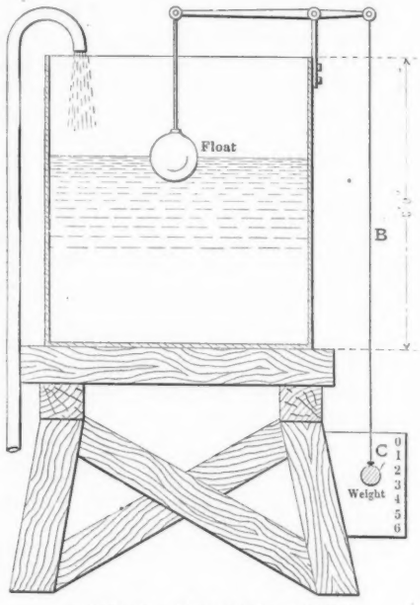
The remedy is to connect the condenser pipe and the lubricators so that there will be no difference in pressure between the two points. The hight of water in the condenser pipe being practically constant, the lubricator's feed will be the same, regardless of the rise and fall of the pressure.

P. J. KEATING.

Streator, Ill.

## Indicator for Water Tank

Water-tank registering devices which have recently been described have an electric-bell alarm attachment. I will submit a registering water-tank device which had no alarm bell, but attached to the string *B* was a little weight *C*, which indicated the hight of the water in the tank and could be read from a distance.




INDICATOR FOR WATER TANKS

GUS. A. JANICKE.

Louisville, Ky.

## Failure of a Cross Compound Engine

In a recent number there was an article by W. H. Wakeman (on page 724) comparing the relative horse-power that can be obtained with simple and compound engines, in which he shows by actual trial that very nearly as much power can be obtained from a simple engine as can be obtained from a compound engine, where the high-pressure cylinder is the same size as the cylinder of the simple engine. This article recalled to my mind a description of the Ball angle-compound engine, published in the March 2 number, from which I will quote a few lines that occur near the bottom of the first column on page 315, as follows:

"It is evident, also, that the floor space of this engine is very small. Since a horizontal engine carries a vertical engine of the same power, the power for a given floor space is, therefore, doubled. This also reduces the cost of the founda-

tion to the same extent, so that practically half the foundation is saved."

As will be seen from the above here are two statements directly at variance with each other. They cannot both be correct, so which shall we believe? Personally, I am of the same opinion as Mr. Wakeman, which can probably be best expressed by saying that while compounding an engine, by the addition of a low-pressure cylinder, may decrease the consumption of steam per indicated horse-power, it does not *to any great extent* increase the maximum indicated horse-power that can be obtained.

DE WITT POURIE.

St. Louis, Mo.

## Condenser or Heater, Which?

We have two 28x48 simple condensing engines running on 125 pounds steam pressure, each capable of developing a little more than 700 horse-power, but at present the load on each does not exceed 500 horse-power. These engines exhaust into a jet condenser. A portion of the condenser water, about 350,000 gallons in 24 hours, is being used to feed steam boilers. A low-service pump pumps water from a hot-well into a Cochrane open heater, where the temperature is raised to 200 or 210 degrees. The condenser water is undesirable for boiler use for the reason that it contains more or less scale-forming matter. We are going to dispense with the use of condenser water in the boilers and begin using city water, which is a soft water and does not contain more than one-half grain of scale-forming matter to the gallon.

We believe that the best installation we could make would be a surface condenser and heater combined, which would enable us to save all the exhaust steam from the engine, as well as heat the water up to 110 or 115 degrees before discharging the water into the Cochrane heater. This installation is quite expensive, however, and we think that we may be able to get almost as good results by installing a closed heater between the engine and jet condenser. We are going to use a closed heater of 3500 horse-power capacity. It is large for the purpose, but it is a second-hand heater and in good condition. The engine will exhaust into this heater. The water from the city main will pass through the heater under pressure. The pressure on the main will be about 100 pounds. We propose reducing the pressure to 15 or 20 pounds before it enters the heater. The pressure will be sufficient to force the water through the Goubert heater and into the open heater. In this way we expect to absorb a large amount of the heat in the engine exhaust in the city water before it discharges into the open heater.

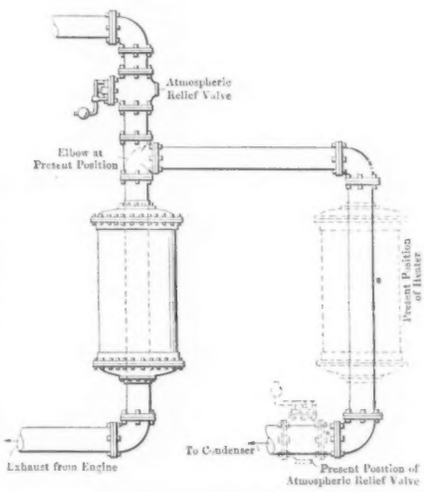
Will a heater between the engine and condenser affect the vacuum? Are there any disadvantages in using a closed heater between the engine and condenser as described? We would like the opinion of engineers on the installation contemplated.

MARKHAM & Co.

Farmington, Mo.

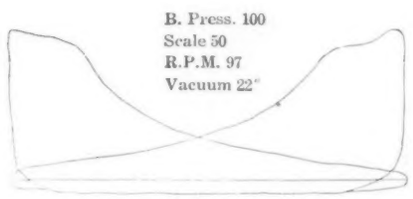
## Condensation in the Exhaust Line

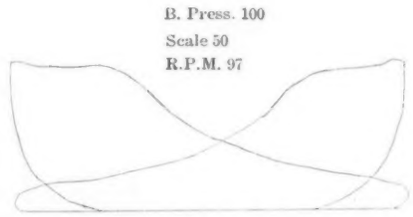
Reading W. O. Perkins' letter in a recent number, regarding the above, calls to mind a similar case I had with the exhaust line on a Wheelock engine, in




HEATER CONNECTIONS

which the water hammer was very heavy at times. The engine and heater were connected up as shown by full lines in the sketch and minus a drain pipe from the bottom of the heater to the condenser. I took this heater out to renew the tubes and put it back in the manner shown by




DIAGRAMS FROM WHEELOCK ENGINE

the dotted lines. There is no water hammer now, all condensation and tube leakage dropping to the condenser.

The accompanying diagrams are from the engine in question, running condensing and on atmosphere, with same load, steam pressure and valve setting as formerly. I would like to see some comment on these from the readers who have been discussing this question. The lead is excessive, but is necessary to obtain reasonably quiet running.

W. J. WILKINSON.

North Bay, Ont.

## Careless versus Careful Engineers

I read with much interest the views set forth on the editorial page, June 2, under the caption, "Careless *versus* Careful Engineers," and can say that after an experience of about 30 years, I fully concur with the views therein set forth.

About 12 years ago I came to Henderson, N. C., to rebuild and overhaul the electric-light plant which had been badly neglected and abused, and in fact, had been shut down about a year because, as the owners claimed, it would not pay expenses. The steam plant consisted of a Ball engine and boiler with a good heater. The electric equipment consisted of one T.-H. arc machine and one of the old a.-c. alternators. These were belt driven, one from each fly-wheel of the engine. The arc machine flashed so badly that it was sometimes necessary to station a man at the machine to start the lights every few minutes, which was done by short-circuiting with a wire. Carbon brushes were used on the exciter, the commutator of which ran so hot that the solder holding the wires in the commutator often melted, and the lights were out sometimes two or three times in one night, and quite frequently a set of brushes would be burned out in one night. I found 14 out of 22 arc lamps hung in circuit the wrong way, thus burning out the coils of the lamp as well as the carbon holders, and as the lamps were inspected and reported when out by the police, I was interested to find that a total of 17 lamps were reported out in one night and a charge of 2 cents per lamp per hour made against the company supplying the lamps. Repairs to lamps for some months were $25. The trouble with the exciter was that the rocker-arm was too far back; that was all.

In the boiler room I found a deep pit in front of the boiler, there being no floor. Coal was banked against the ash-pit doors, which were closed while running, and a steam blower was used under the grates to push and another blower was used in the stack to pull, and still the firemen could hardly keep steam enough to do the work, which was not heavy for a plant of that size. A steam flue blower was used to keep the flues clean, and the boiler had never made the acquaintance of a flue scraper. Upon investigation, I found some of the flues coated until the scraper would not go through, and all were coated with thick, hard soot. Many steam joints were leaking badly.

After putting this plant in shape we were able to build up the business and pay

off the incumberances, and three years ago built a new station which is not surpassed either in building or equipment by any town of its size in the State.

I have one colored fireman who comes on duty at midnight, and runs until morning, and though he has no education and cannot write his name, yet he is intelligent and faithful, and no accident due to his carelessness or neglect has taken place in the ten years he has been running on night duty. He is watchful, and if anything seems to be going wrong he calls me to the telephone and explains the situation by telling me that the "all-nighter" (meaning the alternator) has gone wrong, or the "sheen has gone wrong," and when trouble occurs he does not lose his head or get unduly excited.

GEORGE C. WOODWORTH.

Henderson, N. C.

## For Blow-off Protection

Having lately read with interest several letters on the subject of "Blow-off Protection," I should like to submit the accompanying description of an arrangement which answers the purpose very well. The blow-off pipe is taken straight down from the boiler (see Fig. 1) to about a foot below the level of the combustion chamber, and then out through the rear wall to the blow-off cock and header. The header need not be larger than 2 inches for a battery of four or five boilers, and above that number 3 inches is large enough. The exposed pipe in the combustion chamber is protected by encasing it in 5- or 6-inch fire-clay stove pipe, with bell end, which can be secured from any maker of fire-clay goods.

The space between the blow-off and the clay pipe is filled, as shown in the illustration, with asbestos pulp; or old pipe covering may be beat into powder and used. This serves to keep the pipe from shaking about. The iron wedges, suggested by a recent correspondent, will assist in this.

Everyone knows the disastrous effects of blow-off water striking brick walls and the unsightly and damaged walls that result. To eliminate trouble, run the header into an 8-inch pipe and turn the latter into a creek or other body of water as shown in Fig. 2. By keeping the open end of the pipe about 2 feet under water you will get rid of the blow-off quietly and without any damage to the surrounding buildings. When more than 2 feet of water is allowed above the open end, heavy pounding occurs in the water and the surrounding ground is jarred considerably.

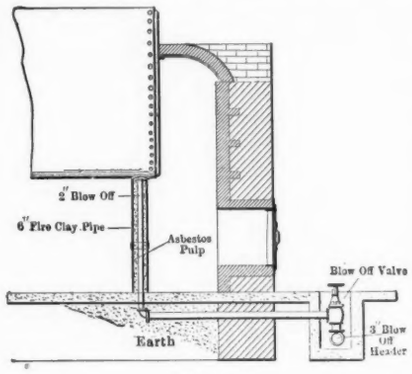



FIG. 1

GEORGE G. BENNETT.

Urbana, Ill.

## The Lake Lifts Itself

There is a hydraulic ram proposition here that comes as near being perpetual motion as anything the writer has seen. I call it making a lake lift its own water 100 feet. This is not a theory, but an account of what has actually been done.

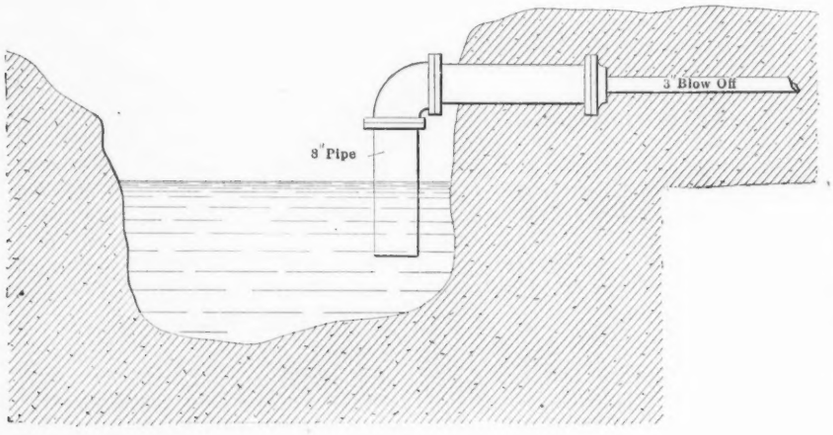



FIG. 2

A hole 18 feet deep was dug only a few feet from the water's edge, a hydraulic ram installed at the bottom of this hole, an intake pipe run on an incline to near the surface of the lake, and a discharge pipe put in connecting with a tank upon the hill.

The intake pipe from the lake is 3-inch reduced at the ram to 1½-inch. The large pipe was put in for the purpose of supplying a larger ram in case the small one worked. The discharge pipe from the ram is ¾-inch and there is about 450 feet of it going up to a tank about 100 feet above the level of the lake. This ram will put 1000 gallons of water into this tank in 24 hours, the impulses being about one for each second.

The discharge water from this ram seeps away at the bottom of this hole. The soil is loose gravel. Now, the question naturally arises, why don't the water from the lake seep through and fill this hole, the sides of which are common wooden well curbing? There is a puddle of water at the ram and this disappears in one minute after the ram is shut off. A larger ram is to be installed, as it is considered that much more water will seep away than at present.

J. E. BATES.

Spirit Lake, Idaho.

## Indicator Does not Detect Leaks

In reply to A. M. Lamb, on page 953 of the June 16 number of POWER AND THE ENGINEER, would say that taking his example of leaks, I would not think of using an indicator to locate the defect in the valve gear of which he speaks. If a steam valve is held open the full length of the stroke, or until the releasing hook knocks the valve shut, which it would have to do, it should be detected without the use of the indicator. If Mr. Smith would adjust the exhaust valve to close later, he would find that the point of release would run down much lower. As to the wavy expansion line, I would like to know if it is caused by a leaky valve. If the leaky valve causes the expansion line to rise, what causes it to fall and make a wavy line? If Mr. Smith will use a little stiffer spring, the leaky valve will in all probability disappear.

In reply to James Smalley and W. C. Light, I would say that taking diagrams to detect leaks is a total loss of time, for in my experience leaks such as have been spoken of can easily be detected without the use of the indicator. The writer had charge of a 2000-horse-power plant in which two of the engines were 750-horse-power cross-compound condensing. One of the high-pressure cylinders was grooved so that half of a lead pencil could be placed between the packing rings and the cylinder wall, also the steam and exhaust valves and ports were grooved in bad shape. These defects were certainly worthy of notice, but it was impossible to detect any leaks from diagrams, and there were some good men on the job. By blocking the engine and giving her steam the leaks were soon found.

GEORGE LYONS.

New York City.

## Finding Steam

That traps are "trappy," as stated in my last letter, on page 64 of the July 14 number, my readers will agree when I tell them that of the 41 of various makes and sizes examined, only one was in good condition. Twenty-six of the 41 were absolutely of no use, as the steam was rushing through as though there were no traps at all, and made it impossible to measure the condensation in the line until new valves were put in and the traps adjusted. As a sample of what was found, six broken valves were photographed under a magnifying glass, and the detail and extent of wire-drawing shows up admirably well, as will be seen by referring to Fig. 1. The picture tells the tale better than any description. The length of time these valves had been in use I cannot say, but recent experience has taught me that the commercial stems do not last very long. In the endeavor to be made cheap, the brass used is too soft. One of the specimens shown (No. 2) is cast, and small blowholes can be detected under a glass. The peculiar grooving is, of course, due to soft spots in the metal, presumably the zinc of the brass washing away and leaving the copper standing. No. 1 shows a feature of soft spots very plainly, as the groove on the side depicts the cutting action of

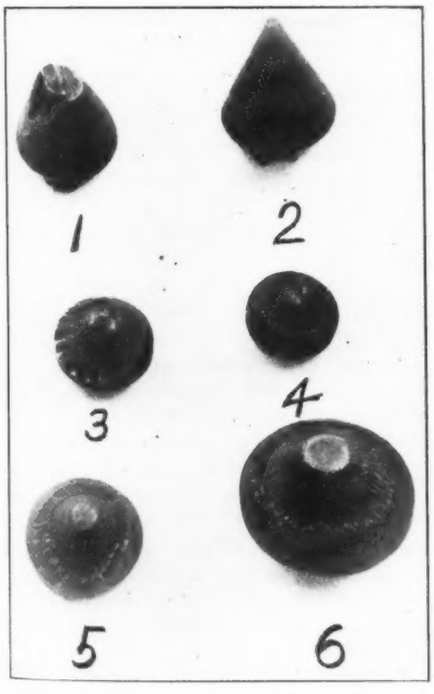



FIG. 1. VALVES WITH STEMS BROKEN OFF

the steam. Unfortunately, the top of this has been sawed off, but it does not affect the sample.

In tracing steam lines feeding manufacturing uses, we have a job that is both difficult and tedious. The trouble lies in the fact that most of the lines of this kind are not put in from a pre-arranged drawing systematically planned, but are the outcome of various patches here and there to meet the needs of various parts of the shop at different times, and are therefore hurriedly executed.

About our plant many of these illogical lines had been run. For instance, from the boiler house to an outlying shop, used now for patterns and wood-working departments, we find two lines, one 6 inches and one 3 inches. A distance of about a thousand feet is covered to this point and in six places en route the 3-inch line is tapped for heaters, small oil pumps, etc., and eventually is headed into the larger one just inside the wood shop. The 6-inch pipe is too large and the 3-inch too small; so, rather than change the intervening connections to the big line and eliminate the small, both are allowed to carry steam all the time.

From the 3-inch line is a 1½-inch pipe running 500 feet uncovered to a new galvanizing plant in the yard, while within 25 feet of this new plant underground is a 2-inch steam main that could and should have been utilized for supply, saving the condensation of the long uncovered line, which, in winter, is a very large item.

Another instance showed a 2-inch line run 300 feet to a small oven. This line crossed a 1½-inch line within 20 feet of the oven, and should have been tapped for a supply. This last case, however, upon investigation, showed up a big source of loss that had been going on for two years. Upon questioning the chief of the pipefitters as to why the extra line had been run, he explained that the other was too small, and there was no pressure. On going over the usages from this line it was hard to understand why with the 165 pounds boiler pressure the drop should be so great, when, on tracing out all connections and usages, a ¾-inch pipe was found to lead directly to the sewer without an intervening trap. My curiosity led me to determine just what the steam loss was and so I half filled a barrel with cold water and made a connection to it from the ¾-inch line near its end. Upon letting the steam discharge into this barrel I found that 1123 pounds per hour had been blowing out of the pipe for two years. This is about 35 boiler horse-power, and estimating that a boiler horse-power costs $3 per month, we have $105 per month or $2520 for the two years, which is the cost of someone's negligence in not seeing that the end of this line was trapped. Needless to say, a trap was immediately installed and now the condensation at this point measures 32 pounds per hour, the trap quickly paying for itself. Of course, after the trap was installed there was plenty of pressure in the line so that the 2-inch line direct from the boiler was entirely cut out and the oven fed from the old 1½-inch line.

Similar practices as the above, too numerous to mention, were found; but one other loss especially has impressed me so that I must tell of it as an illustration of what a leak in high-pressure steam line can mean. In looking over and tracing pipes, I found a 1½-inch line feeding directly into the exhaust-steam, hot-water heater, this return draining, among other things, four steam-heated coils used for warming air blown into ovens. The heaters had been installed hurriedly and no traps put in the four ¾-inch returns. This, then, accounted for the rush I heard in the 1½-inch line; so to make a close estimate on the exact loss occasioned by this vicious piece of work, I placed a steam gage on the return line near where it entered the exhaust system. One hundred and five pounds was registered and, with the help of "Kent," a loss of 19,000 pounds of steam per hour, or approximately 575 boiler horse-power, was estimated, which, at $3 per month per horse-power, is $1725 per month, or $29,325 for the seventeen months it had been going on. These enormous figures led me to to make up the following table which, I hope, will serve as an incentive toward keeping down leaks; for, from every square inch aggregate of leaks around your plant the following shows the waste in dollars and cents:

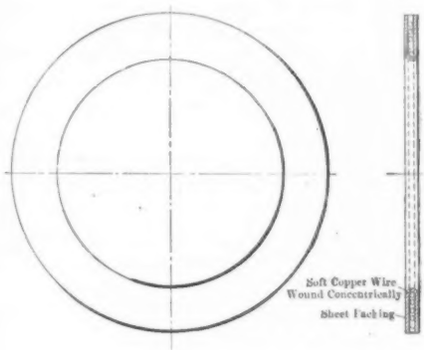



FIG. 2. HOME-MADE JOINT PACKING

| Gage Pressure, Lbs. | Loss of Steam in Lbs. per Hour per Sq.In. of Leaks. | Cost of Loss per Month at $3 per Boiler H.P. per Month. |
|---|---|---|
| 60 | 3,918 | $391 |
| 75 | 4,676 | 466 |
| 100 | 5,925 | 592 |
| 120 | 6,936 | 693 |
| 140 | 7,932 | 793 |
| 150 | 8,787 | 842 |
| 200 | 10,894 | 1089 |

And so from this table it can be seen that the man who is watching the small leaks on the high-pressure steam lines is the man who is saving money. Take the 150 pounds (most up-to-date plants operate on at least that pressure), and if the engineer in charge, by constant watching of his steam lines should eliminate leaks aggregating, say, one-eighth of a square inch, he would save $105 per month, which would at least pay half his salary. How many of us are sure that our various joint and valve leaks do not come to an eighth, a quarter, or even a half of a

square inch; if lines are widely scattered and used for various manufacturing service, why, look out. Besides the leaks, someone might have left out a steam trap.

While speaking of leaks, let me describe a pipe joint I was shown the other day that seems to be calculated to eliminate trouble and leaks. I should not consider it at the present time, except that pipe joints, all more or less bad, occur in so many various forms that a good one is worthy of mention, and I know of the excellent service this particular one is doing and of its cheap though lasting qualities.

The construction is as shown in Fig. 2. A piece of soft-copper wire, about No. 12, is wound in a circle, the inside diameter, of course, to suit the inside diameter of the pipe. A few turns of this wound flat as shown can be held at the ends by a touch of soft solder. Now cut a piece of sheet packing of sufficient width to wrap around the fold on the inside. This packing can be held in place by a heavy thread until the joint is put in. A most substantial joint is thus constructed.

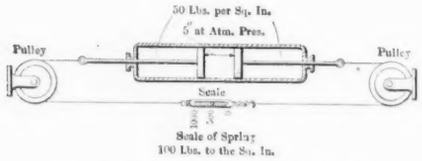
I would, therefore, recommend that in large plants where many steam plants are in use, provision be made whereby an inspection and measurement of condensation be periodically taken. If the work is properly carried out, it would insure the plant against a possibility of a great loss which undoubtedly goes on in many places, due to the fact that few engineers concern themselves about steam traps, as long as the lines drained are kept clear of water; whereas the trap may be losing an enormous amount of steam owing to such conditions as are depicted in the photograph.

WILLIAM LONGSTREET.

Wilkinsburg, Penn.

## A Simple Problem in Mechaincs

Referring to Mr. Manning's problem in mechanics, on page 832 of the May 26 number, my opinion is that the pressure




MR. FENKHAUSEN'S EXPLANATION

registered on the spring balance will be, in both cases, 400 pounds, or the pressure on one piston. If the pressure on one piston were greater than the other in case 2, the balance would register the pressure of the piston having the higher pressure. It is assumed that the space between pistons in case 2 is open to the atmosphere and does not compress air.

It would be an interesting problem for some of your readers to figure the pressure of the spring balance if conditions were as shown in the sketch, the air being compressed between the pistons while the spring balance is being extended until the pressures are equalized. The figure given as clearance between the pistons is with the cords taut and the spring balance registering zero, the piston area being 10 square inches as before.

R. H. FENKHAUSEN.

San Francisco, Cal.

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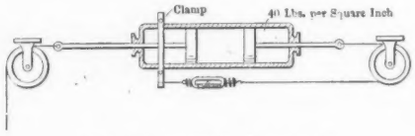
It looks to me to be simply a case of action and reaction, which, of course, are considered to be of equal magnitude. The *effect* on the spring scale would be exactly the same, $10 \times 40 = 400$ pounds, if only one piston were used, as in the accompanying sketch.




MR. CARRUTHERS' SKETCH

Of course, in the case of one end of the spring scale being a fixture to the bracket, the piston would have to travel *twice* the distance that *each* of the two pistons would before being counterbalanced by the pull of the spring scale.

J. A. CARRUTHERS.

Bankhead, Ottawa.

## Trouble on Trolley Circuit

I think I can give a correct solution to M. A. Hamilton's trouble on page 999 of the June 23 number. I take from his letter that he does not understand why the circuit-breakers blow at 550 amperes when the cars are near station and 700 amperes when at the end of the line; also why the kilowatt output decreased. The conditions of the problem were poor rail bondage, the ammeter on the positive side, the wattmeter and circuit-breaker on the negative side.

When the cars were near the station the ammeter registered 500; let us assume the voltage as 500. Now, the line drop is small and let us neglect it. The instruments on the incoming or — wire are nearly under the same conditions as the outgoing wire; that is, the voltage is about the same at both the + and — wires. Then when the load becomes excessive, out goes the circuit-breaker and the ammeter registers somewhere near what the circuit-breaker is set for. When the cars are at the end of the line the line drop, or voltage drop, is large, due to poor rail bondage, and the cars require the same power, so the amperage must be increased proportionally. Seven hundred amperes furnished at the end of a line which has a line drop of 110 volts on a 500-volt system will have no more power than 550 amperes at the generator at the 500 volts. While the ammeter reads 700 amperes, the load on the circuit-breaker is not the same as if it were placed on the other wire. When it goes out the ammeter will read considerably more than that which the circuit-breaker is set for.

The same is true for the kilowatt output, for you probably are still generating the same power only you don't get to register it all. Some power is lost in line transmission, for if 100 volts at 700 amperes are lost in line transmission you lose $700 \times 100 = 70{,}000$ watts, or 70 kilowatts, for whatever time the above conditions exist. The wattmeter placed on the + side would show exactly what the kilowatt output was. The registered kilowatt does not include the line loss. If the circuit-breaker was on the + side it would approximately correspond with the ammeters upon blowing out, but set at 550 amperes one probably wouldn't get enough power to the end of the line.

Mr. Hamilton probably has a heavy line loss and sometime when no cars are running he can determine how much it is by sending a current through the circuit and noting the current when the wattmeter just starts to register. That current times the voltage of the generator, divided by 1000 equals the loss in kilowatts that exists continually while in operation.

G. S. GLICK.

Madison, Wis.

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I would advise Mr. Hamilton to change the wiring of his plant, as described in the following: The circuit-breaker and the ammeter should be placed on the positive or trolley side of the machine, and the series fields and equalizer on the negative, or ground, side. The reason for so placing the series fields and equalizer is because it reduces the potential between them and the ground and lessens the stress on the insulation from breakdown.

It is no more than likely that the load would increase when the rail bonding began to get bad, for then the motormen would keep the motors always pulling on the power plant in order to keep up to the running time, instead of doing more coasting, which could be done if the voltage could be kept up. This increased load not only causes the line drop, but also pulls down the voltage on the busbars; but when the three generators are all on the busses, the voltage can be held up better at the plant, and also on the line to a certain extent. Another apparent reason for the necessity of three generators is in the way they are connected up. The current produced in one machine not only shows partly on the ammeter of the machine in which it is generated, but also on the ammeter of the

other machines, and in this way shows an apparent load on certain machines.

In a sub-station a case similar to this one was noted. Two rotary converters were overloaded, and when a rotary converter in another station a few miles away was thrown in on the same line the total kilowatt output of the two stations was not equal to the kilowatt output that the two converters were pulling.

Although Mr. Hamilton's circuit-breaker was set for 550 amperes, it may not knock out until 700 amperes is reached, and near the station where the line resistance is low a car which is started up too quickly, will take considerable current, because the motor does not get time to speed up and generate a counter-voltage to oppose it. It is probable that the needle of the ammeter swings so fast that the exact point where the breaker goes out is not known.

But out on the end of the line the resistance of the feeder and track is so great that the current does not reach as great an amount when the car is started quickly, and the breaker is not so liable to knock out, i.e., if the load that is already on the line is not near the limit before the car starts; and in this case the needle does not act as quickly and a more exact reading about where the circuit-breaker goes out can be had.

The engine was pulled down on account of the great overload. I judge the large machine to be of about 175 or 200 kilowatts, and when it pulls 700 amperes at 550 volts, the reason is obvious. The amount of current that will flow in the circuit is equal to the voltage divided by the resistance and it matters not whether the rail bonding is good.

JAMES E. KILROY.

Lincoln Place, Penn.

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If Mr. Hamilton's output in kilowatt-hours is decreasing under an increasing load in amperes it would seem that something is wrong with his recording wattmeter. With a constant voltage at the bus-bars and an increasing load in amperes there certainly should be a corresponding increase in output; that is, if his station is direct-current, as I presume. I would suggest that he examine his wattmeter to see if it is gummed up or dirty in its bearings. A dirty or rough commutator on a meter will sometimes cause a great falling off in output as given by the meter.

I have in mind a motor-generator set which as a unit had an efficiency of from 75 to 80 per cent. After running nearly a year there began to be a descrepancy between the input and output, as registered by the wattmeter on the alternating-current end and the one on the direct-current side. The difference increased until the wattmeter showed an efficiency of less than 50 per cent. An examination of the direct-current wattmeter revealed a dirty commutator. A little oil was applied to the commutator, which was then wiped clean with a small piece of dry cheese cloth, when the meter at once resumed its old gait. Before this it would almost stop twice each revolution.

As for the trouble with Mr. Hamilton's circuit-breakers, they should open under a given load regardless of where the cars may be. If the breakers are in first-class condition and of reliable make they should open at the limit at which they are set under any and all conditions.

Mr. Hamilton certainly is not sending out more "juice" from his machines than he receives back at his negative bus. Correct reading ammeters in each side of the circuit will show the same current in each side. Current does not go out from the positive side of the machines to waste away, but returns by way of the negative. Our loss is in volts, not in amperes. If we have a given current flowing through a circuit of a given resistance then we have a loss equal to the number of volts necessary to force this current through the resistance. This is the line loss or drop. Suppose we have 500 volts at the station and wish to deliver 200 amperes through a line the resistance of which is 0.25 ohm. By Ohm's law, $E = I R$, where $E$ = the voltage, $I$ the current in amperes and $R$ the resistance in ohms. Substituting for the values in our problem we have: $E = 200 \times 0.25 = 50$ volts, which represents the loss in the line and leaves but 450 volts available for use. To get the loss in watts, multiply the square of the current by the resistance. In this problem this would be $200 \times 200 \times 0.25 =$ 10,000 watts, or 10 kilowatts, which would be a loss of 10 per cent.

C. L. GREER.

Handley, Tex.

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In the June 23 number, on page 999, M. A. Hamilton speaks of trouble with reference to the load on a circuit and blowing the circuit-breakers. It is not uncommon for circuit-breakers on trolley roads to blow or open apparently at a much less current than that for which they are set, particularly if the demand for current takes place in close proximity to the station. The reason for this is apparently that the demand is so sudden that the ammeter does not have a chance to record the actual current being taken, and that the current actually being drawn from the circuit is largely in excess of that recorded.

Another point is that a sudden demand for power gives a sudden jerk on the tripping device, which causes it to operate at a lower amperage than would be the case if the power came on more slowly. This explains why a car away out on the line, taking 700 amperes, will not open the breaker, whereas one nearer at hand may open it at the smaller value. A car on the line at a long distance from the station, calling for 700 amperes, has all the inductance of the trolley circuit and track, which acts to retard the building up of the current, so that there is no sudden blow or pull on the breaker.

It would be interesting to know the connections on the switchboard of this station, as it does not seem possible that more current is being sent out onto the line. It may be that with the ammeters on the positive side and wattmeters on the negative, there is an interchange of current between the generators, which will show on the ammeters but will not show on the wattmeters. There is no question but that the same current sent out on the line returns to the station. The only loss is in pressure or voltage. I should doubt the question of the instruments being correct or correctly installed.

HENRY D. JACKSON.

Boston, Mass.

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Mr. Hamilton states that he believes they are sending out more current through the positive side of the dynamo than is received back through the negative side. This, in my opinion, is practically impossible, as a generator causes a pressure of electricity between its own positive and negative side only. Therefore, I would consider it just as possible for steam to leak out of one boiler into another which has no connection with it.

In regard to the irregular blowing of the circuit-breaker, I would suggest that it is caused by the imperfect bonds, as bad bonds would cause a ground circuit at the rail joints and therefore offer more resistance; and with this increased resistance the load would come on the engine more gradually, slowing its speed until the voltage dropped back, requiring a greater number of amperes to flow over the coil of the circuit-breaker to electrify it to the blowing point. A little higher steam pressure and a few new bonds would obviate the trouble.

J. R. GRAFFIUS.

West Moshannon, Penn.

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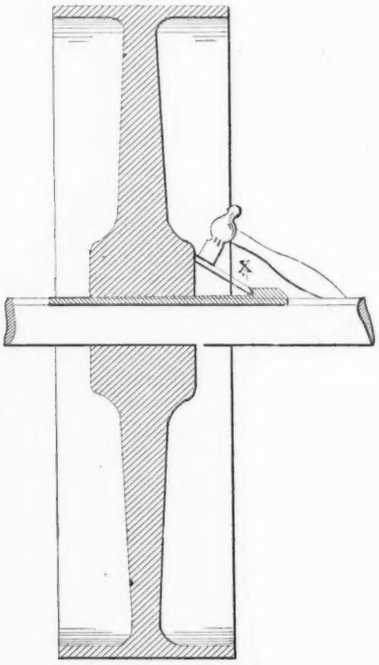
## Drawing a Tight Key

I submit herewith a simple and effective method for drawing a tight key. Take a piece of steel about the width of the key and cut it a little longer than the distance from the hub to the jib of the key. Bevel the ends and place one end against the hub and the other one against the jib of the key, as shown at $X$. Place a punch on the end next the hub and have an assistant drive it down with a heavy hammer.

It frequently happens that one cannot get to the inserted end of a key to drive it out, and if you can it will sometimes swell the end and cause it to drive hard all the way and necessitate the dressing of the key before using again.

Of course, if the key has been driven nearly "home" it will require shorter pieces, and as the key comes out it can be followed up with longer ones. If the



DRAWING A TIGHT KEY

key has no jib on the end, cut or file a notch in it. I have used this method many times and find it effective.

A. G. DAVIS.

Welsh, La.

## Burning Wood and Refuse

I have had some twenty-five years' experience with boilers and engines and I presume nine-tenths of that experience has been with wood as fuel, in such forms as cordwood, slabs, sawdust, shingle splints, planer chips, etc. I have set many boilers for this kind of fuel and have had success in burning poor fuels.

Good sawdust will make a good fire on grates as set for coal, but I would prefer to have the grates six or eight inches lower than for coal. For very poor fuel I have placed the grates 24 inches below the bottom of the fire doors and wished for more room still. When wood is very poor a large body of it must be on the grates.

I am partial to the dutch oven for such fuel as the refuse of the shingle mills of this part of the country. Some mills use the dutch oven both as a refuse burner and boiler furnace. This I do not approve of, as constructed here, as all heat must pass under and through the boiler, thus evaporating great quantities of water, to be blown through the safety-valve. All engineers know what that means when water carries scale-forming minerals, whatever the distance from the boiler to the grates. The top of my bridge wall is never straight; it is kept a certain distance from the boiler, which distance is determined by the size of the stack. The area of this opening between the bridge wall and the boiler slightly exceeds the area of the stack or chimney. I never fill the space back of my bridge wall, whatever the depth.

The explosion of gases generated in the furnace is liable to happen where planer chips are shoveled or pushed into the furnace in large quantities at one time. I have known of persons being quite severely burned. On several occasions it has been a source of fun, although I have been scorched some myself.

WILLIAM YATES.

Seattle, Wash.

## Coal Pile Extravagance

The article on "Coal Pile Extravagance," in the June 23 number is timely and indicates a step in the right direction. While the author of the article has clearly pointed out the principal factors affecting the actual value of the coal it is apparent that he has made an error in one of his illustrations. In the first illustration, there is a difference of more than 1200 B.t.u. in the heating power of each of the samples *A, B, C*. He has shown that this affects the value of the coal to a marked degree, but when he takes up samples *D* and *E*, he overlooks the small difference of 142 B.t.u. The author is showing how the cost of ash removal affects the value of the coal and makes the following statement:

"The determining factor here in the proper valuation of these two coals is the ash."

Following his own reasoning it is clear that the ash removal is *not* the "determining factor," although an important one. It is stated that sample *D* contains an excess of 142 B.t.u. per pound over sample *E*. The total lot of 10,000 tons would contain, therefore, a *balance* of $10,000 \times 2240 \times 142 = 3,180,800,000$ B.t.u. The purchase price of these heat units is \$3 for $13,390 \times 2240$, or for 29,993,600. Consequently, the value of the balance, or excess, heat units is

$$3 \times \frac{3,180,800,000}{29,993,600} = \$318.$$

In other words, we must purchase 10,106 tons of *E* coal to get the *same heat* as we do from coal *D*. The balance sheet would then stand:

| | | |
|---|---|---|
| 10,000 tons of coal *D* at \$3..... | \$30,000 | |
| 1,264 tons of ash to be removed, at 25 cents..... | 316 | |
| Total cost of using 10,000 tons of coal *D*..... | | \$30,316 |
| 10,106 tons of coal *E* at \$3..... | \$30,318 | |
| 305 tons of ash to be removed, at 25 cents..... | 76.25 | |
| Total cost of using 10,000 tons of coal *E*..... | | \$30,394.22 |
| Saved by buying coal *D*..... | | 78.55 |

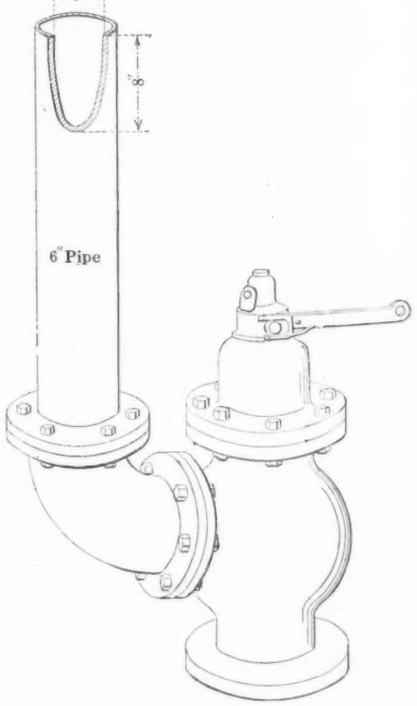
While the above figures are given to back up my opening statements, yet these calculations as well as the author's, for this particular illustration, are more or less a "juggling with numbers." It would be as absurd for anyone to maintain that there would be an actual saving of \$78.25 on the 10,000 tons as it would be to claim a saving of \$240.50 for the other coal, although, under the conditions stated, the former figure is undoubtedly more nearly correct. The point is this: When we state the saving to an even dollar, it implies an accuracy of $\frac{3}{1000}$ of 1 per cent.! The statement of the number of *cents* makes it still more ridiculous. Now it is not probable that the heating value of the coal is determined with greater accuracy than ½ of 1 per cent. If this is so, we cannot calculate the actual value of 10,000 tons within \$150. There seems to be something impressive about sums carried to the last cent and the larger the sum is, the more the implied accuracy by carrying the last cent. We might better disillusion ourselves, however, and reeognize the true facts of the case.

L. H. RITTENHOUSE.

Philadelphia, Penn.

## To Stop the Roar of a Safety Valve

The other day the foreman of a boiler shop came to me and began talking about




TO STOP THE SAFETY-VALVE BLOW-OFF FROM ROARING

safety valves. He said his firm had installed a new battery of boilers for a large sash and door factory, and every time the safety valve blew it made a roaring noise

and shook the mill. I told him that I had had the same experience, and stopped the racket by the following means: I took down the blow-off pipe and cut out a 5x8-inch piece from the top, as in the sketch. The result was a quiet, steady blowing off.

HENRY ROEDER.

Oshkosh, Wis.

## Testing a Gage at Zero Pressure

On page 967 of the June 16 number an inquirer asks what to do when a steam gage does not show zero when there is no pressure in the boiler. The answer given is as follows: "If a steam gage does not register zero when there is no pressure in the boiler, test and adjust it," etc.

Is a thought often given as to what it means to test a gage at zero pressure, with no tension on the spring either way? I once took a position where this condition existed. The heating was guaranteed to be done "with the exhaust pressure at zero on a compound" gage. The ice machines were guaranteed to operate with 2 pounds back pressure. There were four engines, on each of which 1 pound back pressure meant 5 horse-power resistance.

Each ice machine was fitted with a 12-inch dial, low-pressure steam gage, and there was one 12-inch dial, compound gage on the main exhaust, besides two smaller pressure gages. The ice-machine gages registered nearly alike, but not as much as the compound gage.

I finally got the ice machines to run without back pressure by their gages, but the compound showed irregularly, and I finally decided that none of them was correct at zero and sent them all to be tested and adjusted.

When they returned they appeared about the same, and I began to study out how one could test the accuracy of a spring when there was no pressure on it. I had a compound mercury gage made to show 10 pounds plus and 10 pounds minus.

When this was put in the system it showed that the mercury would go up 3 pounds on one and 4 pounds on the other ice-machine gage, before they would move off the pin. The pressure would vary from 2 to 3 pounds without the compound showing much difference around the zero mark, and I saw that measuring pressures at zero with a spring gage was wholly unreliable if the pressure was important, as it is in trying to keep zero pressure on exhaust steam.

In this case there could have been 30-horse-power resistance added to the engines with not a particle of good from it and still not be indicated by the gages. Running with ordinary pressures, the gage not standing at zero at no pressure is an indication that the gage may be out and is always noticed if the pointer does not come back against the pin. If it were an actual test, it would show that the gage indicates more pressure than really exists in the boiler and is therefore safe.

Somehow, when the pointer comes back against the pin, the pressure of the pointer on the pin is never questioned. There are many cases where if the pin were taken out the pointer would go way past and onto the negative side, and in this case, if the pointer not standing at zero were a correct indication, it means that more pressure is being carried on the boiler than is indicated, and yet nobody advocates the leaving out of the stop pin.

Should this pin be left out it would be an exceedingly rare thing to see a gage standing at zero when there was no pressure.

W. E. CRANE.

Waterbury, Conn.

## Correcting for Superheating

F. E. Matthews' article on "Correcting for Superheating," in the June 2 number, contains information of the greatest importance in figuring boiler tests in which superheat must be taken into account if the boiler is to receive the credit it should have. However, the example as figured out by Mr. Matthews needs some revising, as the specific heat of superheated steam at the given pressure and temperature, according to some of the latest investigations, is not 0.475 nor 0.48, as given, but varies for different pressures as well as for different degrees of superheat.

Let us take the same figures Mr. Matthews used, together with the same symbols, in order to avoid confusion: Steam pressure, 141.3 pounds; feed temperature, 125.2 degrees Fahrenheit; temperature of superheated steam, 506.8 degrees; evaporation per pound of dry coal, 7.476 pounds; temperature of saturated steam of given pressure, 361.3 degrees Fahrenheit.

The formula given by Mr. Matthews for finding the equivalent factor of evaporation when superheat must enter into the calculation is

$$F'S = \frac{H - h + s}{965.7},$$

or

$$\frac{H - h + S'(t - t')}{965.7},$$

where

$F'S$ = Equivalent factor of evaporation;
$H$ = Total heat in saturated steam above 32 degrees Fahrenheit,
$h$ = Total heat in feed water above 32 degrees Fahrenheit,
$S'$ = Specific heat of superheated steam at given pressure and temperature,
$t$ = Temperature of superheated steam,
$t'$ = Temperature of saturated steam at given pressure.

By the use of the above formula Mr. Matthews states that the equivalent factor of evaporation equals 1.209, or an evaporation per pound of dry coal of 9.38 pounds of water (which should have been 9.038 pounds of water) from and at 212 degrees Fahrenheit, and by the use of Mr. Wood's formula the equivalent factor of evaporation equals 1.269, or an evaporation per pound of dry coal of 9.48 pounds of water from and at 212 degrees Fahrenheit.

The formula given by Mr. Matthews is correct. He does, however, make a mistake in assuming the specific heat of superheated steam at 0.475. The specific heat of superheated steam at 156 pounds pressure (absolute) and a temperature of 506.8 degrees Fahrenheit is 0.562, according to Professor Thomas' experiments published in POWER some months ago. Professor Thomas' values for the specific heat of superheated steam are generally accepted as being correct and can safely be assumed so until someone demonstrates by further experiment that they are not.

With this value of 0.562 for specific heat substituted in the formula as given by Mr. Matthews the equivalent factor of evaporation equals 1.2229, or an evaporation from and at 212 degrees Fahrenheit of 9.142 pounds of water per pound of dry coal. To illustrate the effect on a boiler test for efficiency of making the wrong assumptions, or using a formula which we are not able to check, let us assume a coal having 12,500 B.t.u. per pound dry and figure the efficiency for each of the above results:

First

$$\frac{9.038 \times 965.7}{12{,}500} = 69.8 \text{ per cent.}$$

Second

$$\frac{9.48 \times 965.7}{12{,}500} = 73.2 \text{ per cent.}$$

Third

$$\frac{9.142 \times 965.7}{12{,}500} = 70.6 \text{ per cent.}$$

With the above before us it is very evident that Mr. Wood's formula gives results far too high and that in order to get the true boiler efficiency when generating superheated steam we can use the formula as given above and the specific heat corresponding to the pressure and degree of superheat obtained during the test, and not the constant of 0.475 as given by Mr. Matthews.

NORMAN S. SLEE.

Barberton, Ohio.

In Joseph King's letter on "An Appeal Examination," on page 66 of the July 14 number, Question 6 was inadvertently omitted, although its answer was given. The question was: "Where is the weakest place in a Stirling boiler?" The answer is: "Longitudinal seam of the steam drum."

# Trade Opportunities in South America

By W. de Moreira

My sojourn of four years in South America, traveling most of the time throughout Brazil, Argentina, and Chile, gathering data concerning commerce, has proved to me that as a rule the American manufacturer does not know what a big field he will find there for his goods. English, German, French, Italian and even Belgian manufacturers are aware of the commercial opportunities in these various republics and devote more attention to the South American market than the Americans themselves. The Japanese, the Yankee traders of the Far East, understand this so well that, aided by their government, they have established a steamship line which runs from Japan to Chile, and have arranged a postal money-order exchange between the two countries.

How is it that the American manufacturer, who is generally so keen regarding commerce, is lagging in the rear and letting other nations have nearly a free control over this Golconda? This question is hard to answer without hurting our pride somewhat, but bluntness, I think, will be more appreciated than an apologetic statement. The truth is that we are very ignorant regarding South America. We hardly know the geographical locations of the different republics, and have slight knowledge of their languages, means of transportation, banking systems, etc.

A few years ago, while getting ready to start on my journey to Brazil, a gentleman from Boston asked me to send him some data regarding the rubber industry in Para. Before leaving his office he said to me: "I have a friend somewhere in Brazil who could furnish me all these details, as he has a large rubber plantation; unfortunately, however, I have lost his address." When I asked him if that friend was living in the state of Para, he answered that he was positive his friend did not live there; in fact, he knew he lived in the state of Yucatan, but could not remember the name of the town. Yucatan is a state of Mexico, some 6000 miles from Para, which is in the northern part of Brazil. I have had many people express astonishment and sometimes disbelief when I told them that Portuguese was spoken in Brazil. Some thought Spanish was the language, while others thought it was English, and an Illinois manufacturer told me it was "dago."

## The Small Amount of Our South American Trade

The American manufacturer will understand quickly enough the value of commercial opportunities in South America, when he knows that the foreign trade there during 1907 amounted to $1,513,415,000, of which the share of the United States was only $233,293,300, including both exports and imports, or barely one-seventh. Going more into detail, he will see that South America sold us products to the value of $147,680,000, and bought from us only $85,612,400, leaving a balance against us of practically $60,000,000. Is not this the best of proof of my assertion that the American manufacturers are lagging behind other countries in their exports to South America?

There is no doubt, however, that we have improved our export conditions in the last ten years. The figures which I will give, and which were obtained from the report of the Bureau of the American Republics, ought to be an incentive to the manufacturer and also a proof that there is a good field for him there. The entire commerce, exports and imports, between the United States and the countries to the south in 1897 amounted to $252,427,798. Three years later, in 1900, this had grown to $324,680,368; in 1905 it had expanded to $517,477,368; in 1907 it had reached the total of $587,194,945. Thus in ten years our trade has increased by the vast sum of $335,000,000, or more than double.

## Some Countries are Very Progressive

The scope of this article does not permit me to treat at length of the greatness and importance of various countries of South America. I must, however, say a few words on Brazil, a country so large, so full of resources, so great in openings, that one finds it hard to believe that such a country possesses so many opportunities. If the manufacturer knows that the entire area of the United States could be placed inside the limits of Brazil and there would be still room for Germany, that Rio de Janeiro is a city of more than 1,000,000 inhabitants, that all over Brazil there is evidence of progress, that railroads are being built, that harbor and rivers are being improved, that factories are being erected, he will readily believe that no country in South America furnishes him with more chances to build up his trade.

Uruguay and Paraguay are small, but progressive. One is improving its harbor, the other its river and rail service in order to be in touch with its neighbors, Argentina and Brazil. Argentina is a very progressive republic and possesses a perfect railroad system. It is enough to say that her foreign trade during 1907 shows a total value of $582,065,052 gold, covering imports worth $285,860,683 and exports worth $296,204,369. Chile, wealthy through its nitrate fields, has also a great future and its government is preparing to spend $10,000,000 for harbor and dockage facilities, which will make it the most complete port on the Pacific ocean.

All these countries, Bolivia, Peru and Ecuador, need machinery, tools, engines, mining and electrical apparatus, etc. All these countries will, I am sure, buy much of their goods from American manufacturers if they only know about them; but as a rule they don't.

American manufacturers have a great object lesson in the Germans, who, manufacturing in many instances goods of a quality inferior to ours, have, nevertheless, "the cream" of the exports in South America, because they cater to the public in an intelligent manner.

## Know that Your Salesmen Speak the Language of the Country

An American thinks he can do business in South America as he does in Chicago; he is greatly mistaken. If you wish to succeed in the South American market send somebody there who can speak Spanish and Portuguese—not somebody who says he can, but someone you are positive knows the language. I have met in Rio an American salesman who did not speak one word of either Spanish and Portuguese, but who, having told his firm in New York that he knew these languages well, was taken at his word, with the result that not being able to carry out his bluff he returned home with more of an expense account than results warranted, while the orders he sent to his firm were obtained mostly through charity and good fellowship of a few Americans residing there.

Although a salesman may be of the best here, it does not mean he will be so there. An aggressive, breezy man will succeed in Chicago and may fail in Boston. A salesman in South America, to be a success for his firm, must unite business knowledge with diplomatic tact, sharp trade acumen with suave manners. He must have his literature written in Spanish and Portuguese; English is not understood. Of what good would it be to the American manufacturer to receive a catalog in Chinese or Japanese? He might keep it as a curiosity, but he would not understand it. Your catalog printed in English has not even the merit of being a "curio" in South America.

## Be Careful in Filling Orders and Packing

But there is another reason why the American manufacturer does not succeed in his South American export trade, and that is his independence in filling an order received from a foreign country. It would seem rational that he would be only too glad to fill the order according to instructions; however, this is not so, and the unfortunate methods of conducting business followed by a large number of American manufacturers are bringing every day disastrous results. I know of the case of a South American house which wrote to an automobile firm in New York for quotations on automobiles. The quotations were given and six machines of 25 horse-power each were ordered. The American firm shipped six machines of 30 horse-power, writing that it did not have the machines of 25 horse-power, and billed

the machines at the increased price. They were, so I understand, refused, causing a loss to the shipper as well as to the buyer, making him, moreover, disgusted with the methods of that firm.

The same experience happens daily in regard to packing. I have seen machinery which, on arrival, had to be refused on account of not having been packed according to instructions; naturally the buyer did not wish to expend his profit in repacking it for narrow-gage railroad and mountain transportation.

As soon as the American manufacturers will appreciate the difference between conditions they prepare for in shipments in the United States and those to be prepared for in transoceanic shipments they will progress rapidly in the export business.

### South American Credit

Another stumbling block for the South American export is that the American manufacturer still clings to his own ideas of credits and is losing business right along by reason of it. The need of American banks in South America is becoming a daily necessity and one cannot but wonder why the American people have delayed the establishing of banks of their own in the various South American republics. The Germans, the English and even the French have understood the immense advantage of helping their trade by having banks of their own. In this manner they safeguard their interests, as far as credits are concerned, and they obtain most valuable inside information as to the general trade and financial conditions of business houses. A point to be noted is that actually all banking profits resulting from commercial operations between South America and the United States benefit corporations foreign to the United States. That such profits are very considerable is evident by a study of the different bank statements. I personally know that the yearly profits of a foreign bank in a town in Chile, where there are six other foreign banks, is nearly 60 per cent. on the capital stock.

London is a great factor in the bank transactions in South America. Remittances are always arranged through London. In other words, if a South American buyer must send money to New York he buys from a banker there a draft on a banker in New York. The price of this draft is subject to two conditions: the rate of exchange between that country and London, and between New York and London. Once the draft is issued, some London banker is credited with the amount; this amount is drawn on him by the New York banker when the draft is paid in New York. The opening of an American bank in South America would force the settlement to be made direct between New York and these banks, and the profits obtained therefrom would be considerable.

The establishment of American banks would also facilitate credit, although nowadays South American buyers do not require such long credit as formerly; commercial paper is discounted now by the banks, thus enabling the purchasers to buy for cash or on short credits. The present general method of credit in South America is to buy at 90 or 120 days with interest of 10 per cent. from date of invoice. The jobbers who thus purchase sell to the retailers on 60 days' credit. The retailers sell for cash. Thus the lack of capital is well assisted by a good credit system.

It seems to me that the American manufacturers could make arrangement with some English banks which have agencies in South America, as well as in New York, to transact their business and to furnish them all the information regarding the credit and standing of commercial houses there.

### Ships to South America

There is another point which the manufacturer is not well posted on; that is, the status of the transportation facilities between New York and the various republics of South America. They say: "We have no mercantile marine and, therefore, we are obliged to send our goods to England and have them transhipped." It is certainly sad to see ships entering the southern harbors every day flying the English, German, French, Austrian, Italian and Spanish flags, and only once in a while some small sailing vessel flying the Stars and Stripes. It does not behoove me, however, to create an argument for subsidy. No doubt the time is near when Americans will realize the necessity of having a good merchant marine; meanwhile they should realize which is the best way to send their merchandise.

Certain manufacturers were complaining to me some time ago that it was too bad that only one ship sailed monthly from New York to Brazil, and they were much astonished to hear that they could ship their goods direct every week if they so desired. As a matter of fact there are nine sailings a month from New York to Buenos Ayres, about seven for the south of Brazil, and as many more for the north, four to Chile via the Straits of Magellan, and 12 via Panama, with transhipment at Colon.

There is no doubt, however, that a well-established line of American steamers running weekly or fortnightly to South American ports, with prompt and well-kept schedules, will be of immense value to establish confidence and to augment trade between the two Americas. The manufacturer has all the opportunity to ship his goods direct; the only thing of vital necessity for him to remember is that the countries there are not like the United States, that the means of local transportation are not as perfect as ours, and that, therefore, he must pack his goods well and ship them according to instructions.

## Determining the Sizes of Alternating Current Line Wires

By N. A. Carle

The exact calculation of alternating-current circuits involves variables representing the amount of power to be transmitted, the voltage of the current, the length of circuit, the allowable percentage loss of power in transmission, the system used and the resistance of the circuit.

The resistance of the circuit depends upon the ohmic resistance of the metallic circuit, the skin effect, self-induction and capacity effects. The skin effect varies with the size of wire of the circuit, and the frequency of the current. Self-induction varies with the frequency of the current, the size of wires, the spacing of wires of the circuit, the length of the circuit and the amount of current per wire. The capacity effect varies with the size of wires, the spacing of wires of the circuit, the length of the circuit, the voltage between wires and the frequency of the current.

A circuit containing resistance, inductance and capacity opposes the passage of the current with a resultant effect called "impedance." The formula* is much too complex for ordinary commercial calculations.

When alternating currents were first used, all calculations were made using the direct-current formula. This gave satisfactory results with small currents and short distances, with the wires close together. When alternating-current circuits are run with the wires spaced 1 inch apart or less, the self-induction can be neglected and calculations made as for direct-current circuits. However, when high voltages and long transmission lines, carrying large currents at various frequencies and power factors, began to be used, it was necessary to give consideration to impedance, frequency, power factor and the system used in connection with these transmission lines. Complicated formulas have been designed to cover the existing conditions. These have been somewhat simplified by tabulated values for several of the variables for the range of ordinary commercial operations and by the use of calculating diagrams. A very complete presentation of the calculation of high-tension transmission-line formulas for a sixty-cycle system is that given in Foster's "Electrical Engineers' Pocket Book," by Ralph D. Mershon. Values for resistance-volts and reactance-volts per ampere per thousand feet of line are tabulated for different wire sizes and spacings between wires. The percentage which each is of the delivered voltage is calculated and by using these values, with the power factor of the system, the per-

*$Impedance = \sqrt{Resistance^2 + (Inductance \backsim Capacity)^2}$

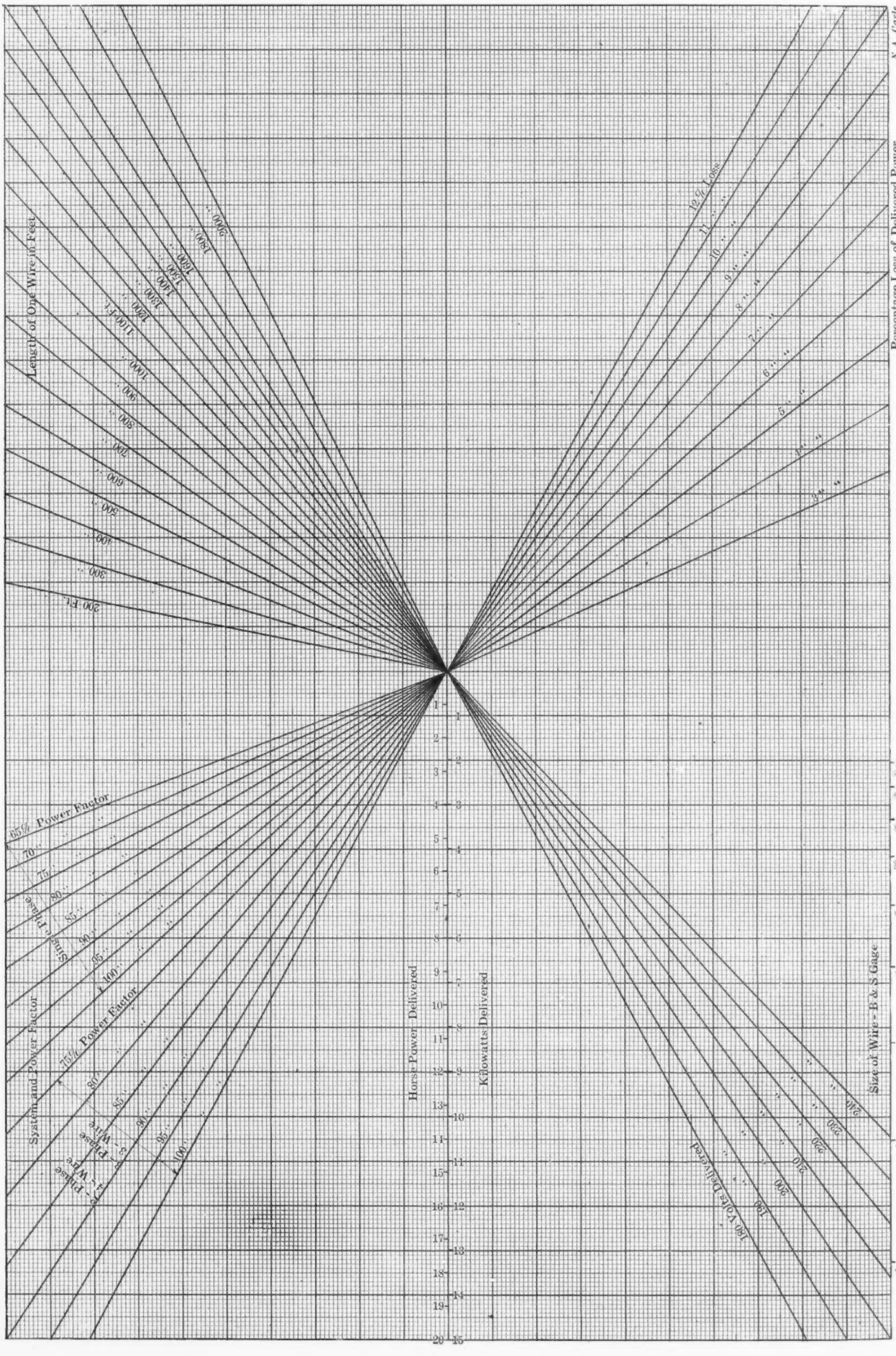



CHART FOR DETERMINING THE SIZES OF ALTERNATING-CURRENT LINE WIRES DELIVERING FROM 1 TO 15 KILOWATTS

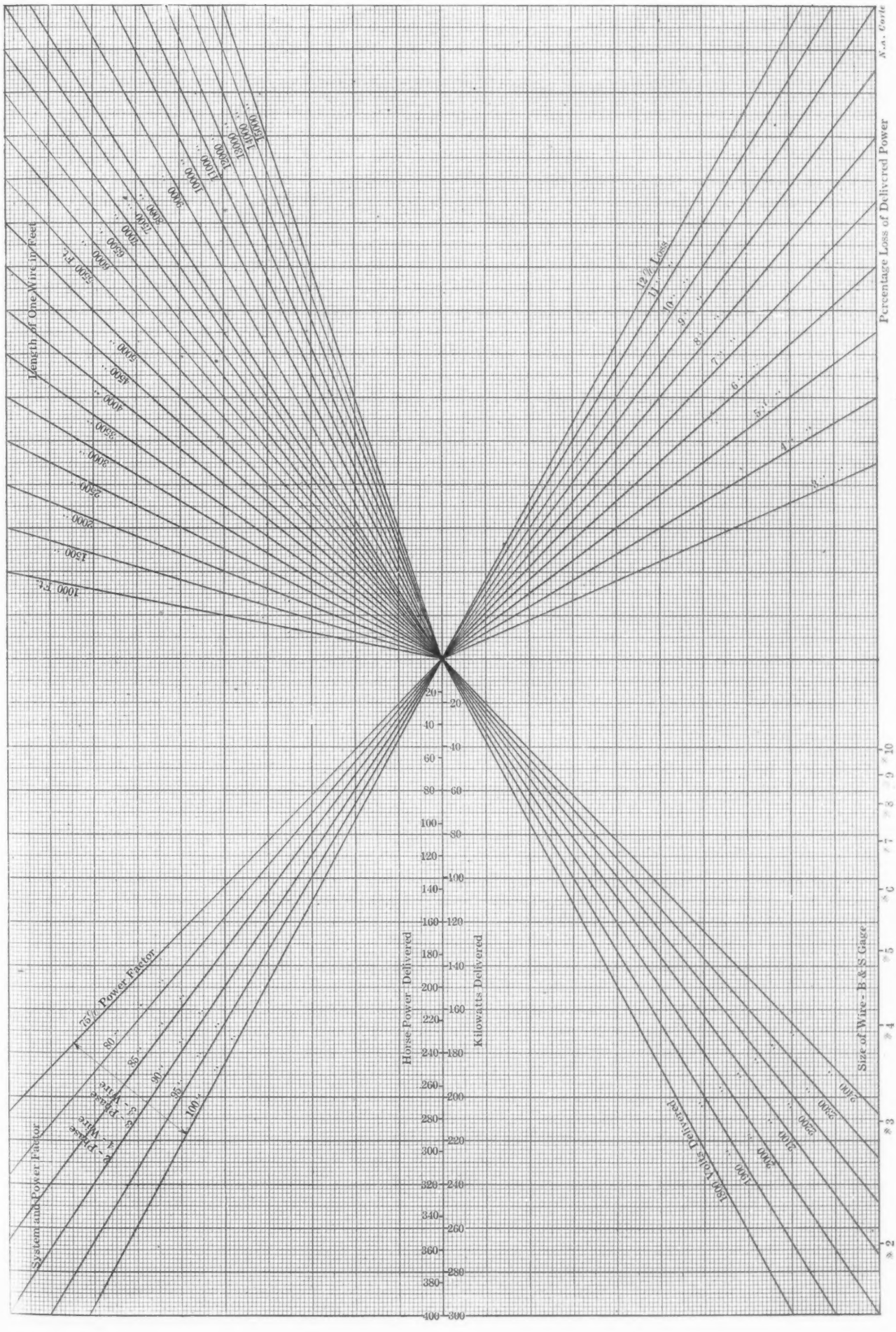



CHART FOR DETERMINING THE SIZES OF ALTERNATING-CURRENT LINE WIRES DELIVERING FROM 20 TO 300 KILOWATTS

centage of drop in the line is determined graphically by means of a calculating chart. If this drop is excessive, a larger size of wire is selected and the calculations are repeated until the desired drop is found.

For service lines for 110 to 2200 volts, of one-, two- and three-phase circuits, carrying up to 300 kilowatts, such as prevail in the distributing system of a city, neither the simple direct-current formula nor the complicated one for high-tension transmission lines can be applied for calculating the size of mains. A simple formula is given by Oudin in his book on "Standard Polyphase Apparatus and Systems," based on Ohm's law and modified by the use of constants which experience shows give satisfactory results in actual practice.

The formula is:

$$circ.\ mils = \frac{D \times W}{P \times E^2} \times K,$$

in which

$circ.\ mils$ = Area of conductor in circular mils,
$D$ = Distance of transmission (one way) in feet,
$W$ = Total watts delivered by the line,
$P$ = Percentage loss in line, of the total delivered watts,
$E$ = Voltage between main conductors at the delivery end the line,
$K$ = A constant varying with the power factor and system as follows:

| Power Factor. | Single Phase. | Two Phases, Four Wires or Three Phases, Three Wires. |
|---|---|---|
| 1.00 | 2160 | 1080 |
| 0.95 | 2400 | 1200 |
| 0.90 | 2660 | 1330 |
| 0.85 | 3000 | 1500 |
| 0.80 | 3380 | 1690 |
| 0.75 | 3850 | 1925 |
| 0.70 | 4420 | .... |
| 0.65 | 5120 | .... |

The values of $K = \frac{2160}{p^2}$ for single-phase circuits, and $\frac{1080}{p^2}$ for two-phase, four-wire, or three-phase, three-wire circuits.

The above formula is in general use by companies furnishing alternating-current lighting and small power service, and is found to give satisfactory results within the range for which it is usually required, if the percentage of loss in line is limited to 5 per cent. for lighting circuits and 10 per cent. for power circuits. The loss is reckoned in percentage of the *delivered* power. No further calculation is required to determine the volts lost in the line or the current in the main conductors.

The charts on pages 162 and 163 are designed to present a graphical solution of this formula within the limits ordinarily found in commercial practice, for 220 and 2200 volts.

EXAMPLE

What size wire will deliver 12 kilowatts at 200 volts over a distance of 900 feet, at 85 per cent. power factor, using a three-wire, three-phase system, and allowing 10 per cent. drop in transmission?

Use the chart designed for a total of 15 kilowatts delivered, starting with 12 "Kilowatts Delivered," read up to 85 per cent. "Power Factor" under the head "Three Wire, Three Phase," thence across to 900 "Length of One Wire in Feet," thence down to 10 per cent. "Loss of Delivered Power," thence across to 200 "Volts Delivered," and down to the result, which is found to be No. 4 B. & S. wire.

EXAMPLE

What size wire will deliver 240 kilowatts at 2300 volts over a distance of 3000 feet, at 85 per cent. factor, using a three-wire, three-phase system, and allowing 8 per cent. drop in transmission?

Use the chart designed for a total of 300 kilowatts delivered. Starting with 240 "Kilowatts Delivered," read up to 85 per cent. "Power Factor" under the head "Three Wire, Three Phase," thence across to 3000 "Length of One Wire in Feet," thence down to 8 per cent. "Loss of Delivered Power," thence across to 2300 "Volts Delivered," and down to the result, which is found to be No. 6 B. & S. wire.

In the problems given it is to be noted that there are eight variable quantities, the size of the wire being unknown and the other seven quantities known. If any seven of the quantities are known, the eighth one can be found by means of these charts. Instead of reading around the chart in one direction, it will be necessary in solving some problems to start at one end from "Kilowatts Delivered" and from the other end from "Size of Wire" and work both ways to the unknown quantity.

In using these charts, it is to be noted that the number of kilowatts or horsepower is the amount that is to be delivered; also that the distance is the length of one wire in feet—in other words, it is the actual length of the pole line, whether the line be single-phase, two-phase or three-phase. The voltage is that which is to be delivered, not the voltage at the station end of the line.

In estimating the power factor, the following may be assumed:

Lighting load with no motors in service, 95 per cent.

Lighting and motors, 85 per cent.

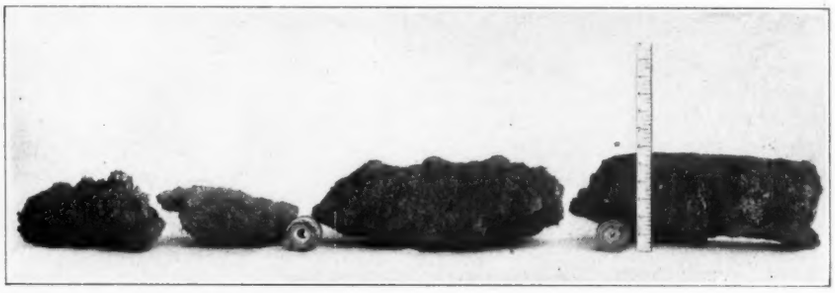
Motors alone, 80 per cent.

In using this chart, the percentage of loss of delivered power should be limited to 5 per cent. for lighting circuits and 10 per cent. for motor circuits.

A circuit used for lighting at night will have more than sufficient wire cross-section for day-motor service with an equal load, but a circuit designed for day-motor service should not be called on to carry more than one-half as much load if used as a night-lighting circuit.

## Value of Personal Inspection *

A few words regarding an engineer who depended entirely upon his subordinates may not be amiss. It is true that the responsible head of a large engineering plant cannot be expected and neither would he have the time to look after every detail, but as will be shown by the following experience, which is only one of many, a personal inspection now and then will often pay well. An inspector visited an unusually large power plant for the purpose of inspecting boilers. Everything about the plant was apparently in the very best condition. At this plant special men were detailed to do nothing but look after the repairs and the cleaning out of the boilers. The chief engineer pointed to one of the boilers, saying, "You may start on that one, but I hardly think it necessary to get inside, as I have just received a report from the man in charge, who reports everything in first-class condition," and on holding a light inside of the manhole the boiler certainly did look to be in excellent condition. However, the inspector, like the man from Missouri, "wanted to see," and it is well that he did. He first got into the manhole above the tubes. The tubes were found



SAMPLES OF SCALE TAKEN FROM BOILER

*Excerpt from paper read by J. W. Rausch before the International Association of Factory Inspectors.

fairly clean, but a solid mass of scale was found on the back head between the tubes and the shell. This scale extended down to the lower row of tubes, the water space being solid with scale for a distance of 1 foot from the back head; also both sides were practically the same. In breaking out the scale, a piece 12 inches long, 3 inches thick and 6 inches wide was secured. An external examination showed that the shell plates at the points where the scale was found were badly bulged and burned. The rivets and the edge of the lap of the head seam were nearly gone. In order to put the boiler in safe condition, extensive repairs were necessary.

## Obtaining a Small Supply of Air Pressure by Water Pressure

By Louis Jones

To anyone who has need of a small supply of air under pressure where water from street mains is available, the following contrivance will prove convenient.

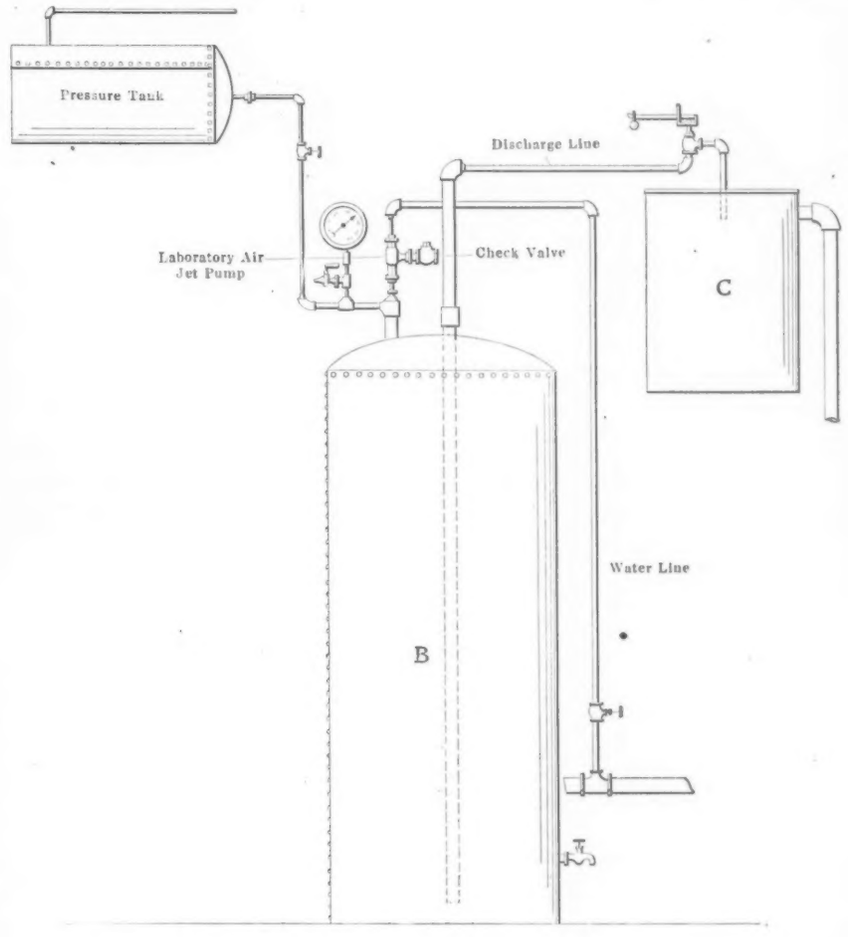
The sketch shows an ordinary 120-gallon hot-water boiler with the bottom plugged. A try-cock is shown in the side opening, and although it is not a necessity, it is convenient to show whether it discharges water or air. At the top is shown the water inlet through an aspirator. The device used in this case is a Schutte & Koerting laboratory water-jet air pump, although an injector, ejector or a cast-iron suction tee will answer when conditions are favorable.

The jet of water entrains air which enters through the suction side through a check-valve and passes into the tank with the water; but, on entering the tank, being lighter, it becomes separated from the water and remains in the upper part of the tank. The air connection, as shown, is from the side opening of a tee. As only two openings were available in the top of the tank, the inlet pipe, being the smaller, was led through the tee and closed nipple a short distance inside the tank. The air discharges from this tee without excessive moisture; in fact, more nearly free from moisture than is common from an ordinary air compressor, for the reason that the moisture in the air is more readily precipitated in the presence of a spray of water than in a dry tank. The supply tank shown should be located in a cold place to dry the air still more, as is the practice with power compressors.

We are using the air to operate a few thermostatic radiator valves. The difficulty in getting a small amount of air at a reasonable cost often prevents the use of an automatic temperature control on a small scale. The water is drawn off through the pipe *B*, shown by the dotted lines to be extended inside the tank nearly to the bottom. At some point in this pipe a spring-loaded valve or a safety valve must be placed to offer a resistance to the discharge equal to the pressure desired. Through this pipe the water is led to any desired point. In this instance, it is discharged into an open tank *C*, to be made use of as if it had not been used for any other purpose, so the question of efficiency does not enter in.

The efficiency is equal to the displacement system at its best, and far greater where high-pressure water is used for low-pressure air, because in the displacement system none of the kinetic energy is made use of. For instance, in compressing air to 15 pounds pressure, 150 pounds of water pressure will do more work than water of 15 pounds pressure by the displacement system; while, by the entrainment system, its energy would be utilized provided the jets were properly proportioned and made adjustable. I see no reason why both systems should not be combined by having the water entrain all the air possible on entering and do the displacing act also. The only test we made for efficiency was to meter both the water and air and we found for each 100 cubic feet of water at 30 pounds pressure we got from 120 to 125 cubic feet of free air (no pressure). The highest pressure we could get with the regular stock pump with fixed jets and 30 pounds of water was 20 pounds of air.

There are a great many places where such an outfit may be used on a larger scale and air compressed without cost. For instance, suppose the pressure on the street mains is 100 pounds or more, and the hight of the building does not require more than 50 pounds to deliver the water to the upper floors, the water can be used to compress air and still have sufficient pressure for the building. In that case, the spring valve may be dispensed with, as the head against which the water discharges would be sufficient. In case the water is discharged into an open heater or tank, it is a simple matter to put a resistance in the discharge line to get the desired air pressure. This is, of course, just a modification of the Trompe blower, or the Taylor system of hydraulic air compression, but it seems worth while to call attention to the every-day use possible.




WATER-JET AIR-COMPRESSOR SYSTEM

When preparing for inspection see to it that the man- and hand-hole plates are removed and that the boiler is thoroughly cooled and cleaned both internally and externally. The combustion chamber back of the bridge wall should be thoroughly cleaned out. Also all valves should be tight, so that if there are any more boilers in the battery under steam, the escaping steam will not prevent a thorough internal inspection.

# POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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## Oil versus Coal for Fuel under Boilers

In an article which is remarkable for the conclusions drawn from the published data of an oil-burning test with a boiler of 200 "brake horse-power" (whatever that may be), a Pacific coast writer says:

"The potentiality of Pacific petroleum for steam generation, much less its actuality, has not yet even trickled to the Atlantic intellect through the ordinary pipe lines of communication, should we accept the editorial comments of the contemporary technical press as 'criteria.' The cumulative advantages of cheaper handling, smaller storage, ashless burning and perfect pressure control are met by arguments, antiquated and narrow, as to alleged supply shortage, high costs and waste of steam. The last-century contention that the entire oil production of the country would not keep the Pennsylvania railroad going is too old and feeble long to dam the present annual production of 130,000,000 barrels."

The writer gives 130,000,000 barrels of oil as the total oil production of the United States. At 42 gallons per barrel, and 7½ pounds per gallon, this would mean 20,475,000 tons of oil. One ton of oil should evaporate as much water as one and one-half tons of coal, and at that rate would be equivalent to 30,712,500 tons of coal for steam-making purposes, if the entire oil production of the United States be used for fuel.

Referring to the published data of a test in the same journal the writer quotes the evaporation of 222½ pounds of water from one gallon of oil, showing a fuel value of 4.2 cents per gallon, as compared with coal at four dollars per long ton. The report of the test from which this conclusion is drawn gives the evaporation of 13.12 pounds of water per pound of oil. If one pound of oil evaporated 13.12 pounds of water, it would take 16.95 pounds of oil to evaporate 222½ pounds of water, and instead of the fuel value of oil being 4.2 cents per gallon, as compared with coal at four dollars per ton, its fuel value would be 1.85 cents per gallon. As the cost is two cents per gallon, there is, instead of a gain in the use of oil, a dead loss of over one-half cent for each gallon burned as fuel when coal is four dollars per ton. In a general way it may be said that when coal costs four dollars per ton oil is worth for fuel two cents per gallon, and it goes without saying that the Pennsylvania railroad, as well as the Standard Oil Company, being conducted along lines of good business management, would burn oil in the place of coal had not scientific investigation proved long ago beyond the shadow of a doubt that coal, even with the attendant disadvantages of smoke, ashes, ash-handling, dust, extra labor and cost of transportation, is the cheaper fuel.

In 1907 the Pennsylvania railroad used in its freight service alone six and one-quarter million tons of coal at a cost of ten million dollars—an average price of one dollar and sixty cents per ton. To compete successfully with coal fuel on the Pennsylvania railroad, oil, instead of selling for one dollar per barrel, would command but forty cents, and its fuel value, instead of 2.4 cents per gallon, would be slightly less than one cent.

## Saving Labor in Small Plants

A conspicuous feature in the design of some of the larger power-plant installations devoted to the supply of electricity for heavy traction, is the wide use of automatic and labor-saving devices at various points in the power-production process. The tendency toward specialization in these large stations enlarges the pay roll to the dimensions of a great organization, and for this reason every reliable and useful automatic device, which can at a reasonable first cost be pressed into service, deserves a fair trial, for the annual charges on such a device must be unusually heavy if they exceed the cost of an extra man for the performance of a highly subdivided task. There will always be enough responsibility in the large plants, even with the use of all the best devices for saving labor that can profitably be installed.

Owners of small stations are much more inclined to feel that they cannot install many automatic devices, partly on account of their first cost when purchased in the open market, and partly on account of a feeling that about so many men are required in the plant anyway, and no material reduction in the labor cost can be expected by the use of apparatus which replaces hand or foot work. If a plant is small enough to run through the bulk of the load with one man in the engine room and another in the boiler room per shift, or even if two or three men are needed on each side of the house, it is hard to show a sufficient reduction in labor cost to justify the installation of much automatic equipment.

In the long run, however, the use of labor-saving devices of rugged construction and positive action may produce indirect savings in the operation of a plant which clearly call for their retention in service and trial in similar work. The actual number of men needed may not be reduced at all, but the work of the men on each shift will be made so much more convenient that the loads will be carried in a better manner than when every man in the plant was overburdened with duties. The care of the machinery in a small station calls for perhaps a more varied activity than in a large station where all the work is subdivided, and the proper running of the equipment to secure anything like a fair economy of production, relia-

bility of service, adequate inspection and maintenance, leaves the engineer in the small plant with very little spare time on his hands. Anything that can legitimately be done to lighten his routine duties is that much help toward insuring the better operation of the plant over long periods.

Many steps can be saved by the more general use of pilot incandescent lamps in small stations. If gas engines are in use, it is an easy matter to install a lamp in each igniter circuit which will flash at every spark discharge, preferably connecting it through a relay contact in order to keep the ignition circuit as free from complication as possible. A visual indication of this kind is a useful arrangement when any trouble develops inside the engine cylinders. If it is not convenient to use a lamp, a simple magnetic-inductor included directly in the sparking circuit can be utilized. The use of flashing lamps to indicate the speed of pumps and fans in forced-draft applications costs little or nothing, and enables the engineer of the small station to observe the operation of such machinery without leaving the engine room. The regularity of oil-pump service, particularly when such pumps are located in the basement or any other out-of-the-way corner, can advantageously be transmitted to the engineer's office or to an auxiliary switchboard panel. If an automatic coal-handling system is in service, it may be desirable to bring before the engineer's notice in this inexpensive way the continuous performance of the hoisting mechanism, conveyer or coal-crusher cylinders. Another use of pilot lamps, which can be as readily effected in the small plant as in the large installation, is for signaling different parts of the plant from the engine or boiler rooms. In connection with extension telephone calls for relay gongs, the use of different-colored lights for different telephones saves much time in favorable cases. The use of pilot lamps on exciter motors, when there are several of the latter in a station, has been helpful in switchboard operation, and in stations where considerable flexibility of bus-bar and feeder control is characteristic, the pilot lamp has an excellent chance to facilitate accurate work at the switchboard. On high-tension oil switches, the pilot lamp is an additional precaution against serious shock through careless handling.

The use of such automatic devices as the carbon-dioxide recorder, the curve-drawing wattmeter, recording voltmeter, ammeter, power-factor indicator and recording thermometers enables the attendants in a small plant to get along with less clerical work than is required in the preparation of extensive station logs, but each case must be decided on its own merits in this respect. If the company can afford to buy such apparatus, it is usually money well spent, provided the equipment is checked against some standard at regular intervals. The real need of automatic devices in small stations comes more in the line of apparatus to forestall trouble or to give quick and accurate indications of what is happening when emergencies arise. In this connection it pays to install automatic alarms against low-water supply anywhere in the plant, thermostat fire circuits, automatic equipment to start a second turbine step-bearing pump in case the first fails, circuit-breaker bell alarms and lamp indicators in some cases, and possibly automatic engine stops. Labor-saving devices should either tend to increase the plant's economy of production directly or indirectly, or else should facilitate operating convenience enough to reduce the personal anxieties of the men on duty, through the presentation of exact knowledge of what is taking place in the moving parts of the installation.

## The Personal Factor

"Men are different and always will be different." Almost anybody will vouch for the truth of this old axiom, and nobody is more likely to do so than the inspector of boilers and machinery. In making the visits called for by his vocation, the inspector is constantly in touch with all kinds and manner of men and often finds that there is a material difference of opinion regarding things about a plant. It is this divergence of opinion on the part of engineers and plant owners that brings into play the various personal factors which make the work of the inspector most trying and difficult, and, in the opinion of J. W. Rausch, superintendent of the inspection division of the Maryland Casualty Company, of Baltimore, more difficult than is at all necessary.

In some plants everything is kept in first-class condition, the work is done systematically and every precaution is taken for the welfare and safety of the employees. Inspection in such a plant is a pleasure, not because it is easier or the inspection less thorough, but because the inspector feels that if anything of a dangerous character is discovered, it will be given immediate attention, and the suggestions for improvement, if at all practical, will be carried out to the letter.

On the other hand, there are many plants in which the conditions are just the reverse. The inspector is viewed with suspicion, and many engineers, who are thoroughly competent but have jealous and sensitive dispositions, are under the impression that he is questioning their ability or their method for caring for the boilers, engines and the various appliances under their charge. This, of course, is all wrong. The engineer is in much the same position as bank officials when receiving the periodical calls of the Government examiners. No one doubts their ability, and just so with the engineer. With his daily visit to different plants, the inspector has a chance to compare notes and obtain information not available in any other way. It is thus reasonable to suppose that he is entirely capable of making suggestions even to the most competent of engineers, and likewise may receive some good ideas in exchange.

Another type of engineer is the reckless man, who, for instance, would sooner block the governor of an overloaded engine than be put to a slight inconvenience. The engineer knows that if the belt should break, a fly-wheel explosion is inevitable, yet time and again he endangers the lives of his fellow-employees, and often with the full knowledge of the management. The engineer and management certainly have the right to endanger their own lives and run the risk of a large property loss, but they have no right to jeopardize the lives of their employees. The practice of blocking the governor cannot be too severely condemned.

Then again there are engineers who depend almost entirely on subordinates. In a large plant, it is, of course, impossible for the engineer to look after every detail, but a personal inspection now and then is by all means advisable. Defects are often overlooked, and sometimes purposely, by the man doing the work.

The cases just cited point out some of the conditions with which the inspector has to contend, and show that his task is a difficult one at best. There is, however, another viewpoint from which to look at this question, and that is from the side of the engineer and plant owner. The inspector may not always be courteous or at all diplomatic, and, perhaps, may not possess the faculty of presenting his suggestions in a clear and concise manner. There is always a right way of doing and saying, and with a little tact and discretion things can be done which would be otherwise impossible. It is always annoying to have the inspector find fault with apparatus or methods and not be able to suggest something better, or to have a number of inspectors disagree as doctors often do in the diagnosis of a special case.

To urge the necessity of certain safeguards, it is often advisable to refer to other plants and show from actual practice that accidents have occurred due to the lack of them. If these references are made with discretion, there can be no particular harm, and without much doubt they will go a long way in convincing the management. It should be remembered, however, that plant owners are averse to having their plants discussed by outside parties, and especially so if dangerous conditions are alluded to.

It would thus appear that a better understanding between the management of the plant and the inspector is wanted.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Berry Safety Feed Water Regulator

The Berry safety automatic feed-water regulator, manufactured by the Berry Engineering Company, Chester, Penn., is combined with the usual water column and high-and-low-water alarm, thus making necessary only one machine on the boiler.

A seamless copper float, placed in the water column, responds to the variation of the water level in the boiler, and by means of a lever rotates the pilot-valve which controls the steam admitted to the feed or control valve, or to the whistle for the high-and-low-water alarm.

The water column is provided with internal longitudinal ribs which serve to guide the float to insure it against sticking, or interfering with the operation of the gage and try cocks.

The feed or control valve is always wide open or tight shut, and does not wear from wire-drawing, and the diaphragm is

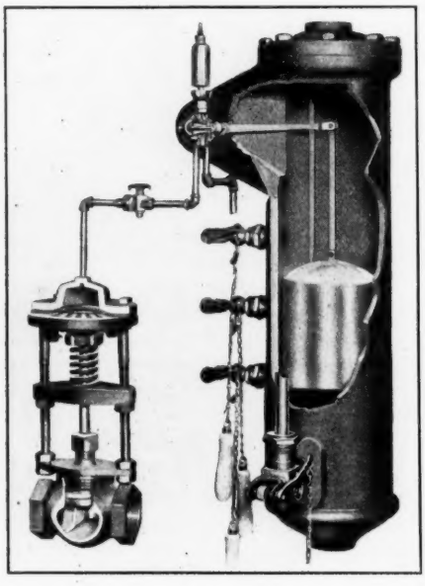


FIG. 1. THE BERRY FEED-WATER REGULATOR

supported by a flexible ring of steel plates that relieve the rubber of all strain. The pilot-valve, Fig. 2, is so constructed that it and its seat can be removed for inspection and cleaning while steam is on the boiler and while the column remains in service showing the water level in the glass. The action of this valve may be understood by reference to Figs. 2 and 3, the latter being a sectional view, show-

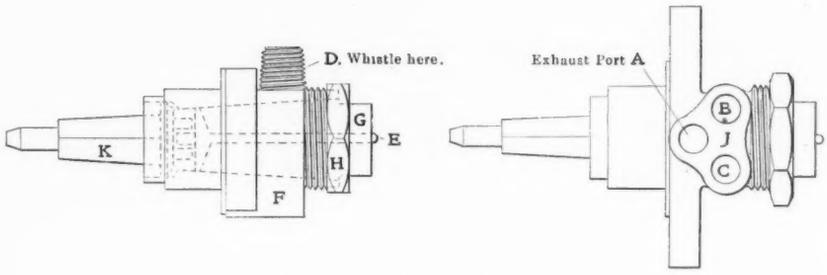



FIG. 2. SIDE AND BOTTOM VIEWS OF PILOT VALVE

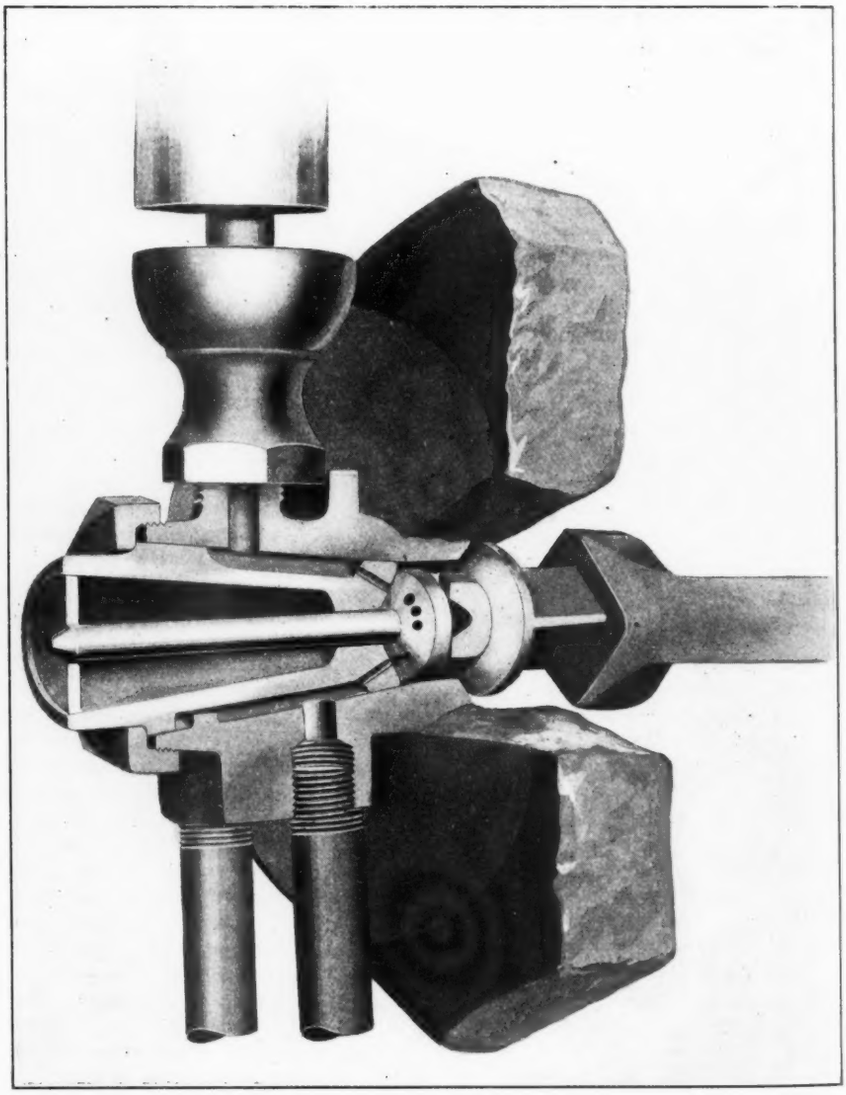


FIG. 3. CROSS-SECTION OF PILOT VALVE OF BERRY REGULATOR

ing the position of the valve when the water is at the level of the center gage-cock. When the nut *H* is about half-way removed, the internal valve *K* will close, and the plug *G* and the valve seat can then be safely taken out. The internal valve stem *K* engages the pilot-valve stem *E* and these parts rotate with the variations in the water level, the plug *G* remaining stationary.

A slight rise in the water above the set level will bring the steam to the pressure port *B*, and at the same time connect the pressure port *C* with the exhaust port *A*. A similar lowering of the water level will bring the pressure to the port *C* and connect the port *B* with the exhaust port *A*. In normal operation the variation never exceeds ½ inch, but if from any cause the water level should not be maintained, the steam would be directed to the whistle port *D*, blowing the alarm for either high or low water. By turning the pilot valve *G* slightly to the right or left, these operations are advanced or retarded and the water level thereby altered.

With the ordinary installation, where a number of boilers are fed from the same pump, a feed-valve is placed in the individual feed line to each boiler, and closed by the operation of the regulator when the water rises above the desired level.

In single-boiler installations, regulation can be obtained with a pump governor in the steam line to the pump; or if a belted pump is used, the control valve can be placed in a by-pass from the delivery pipe to the suction, allowing the pump to run continuously; or a belt-shifting device can be operated to start and stop the pump. This is often accomplished at a great distance, the action being immediate in all cases, as the pipes are full of water.

While primarily intended for use with steam boilers, they have been installed to regulate the water level in hydraulic pressure reservoirs.

## The Cartridge Jump-spark Coil

A new ignition coil which has been put on the market by the Chicago Coil Company, 54 Jackson boulevard, Chicago, is known as the "cartridge jump-spark coil." Its principal parts may be quickly replaced, which seems to be a very desirable feature. In order to get to the parts such as the secondary and condenser windings, Fig. 1, all that is required is to remove four screws from the vibrator end of the box. This allows the primary winding core and vibrator to come off as a unit with the end of the box. The secondary winding or cartridge and the condenser cartridge may then be removed from the box altogether or separately and new ones slipped in or the old ones tested or repaired.

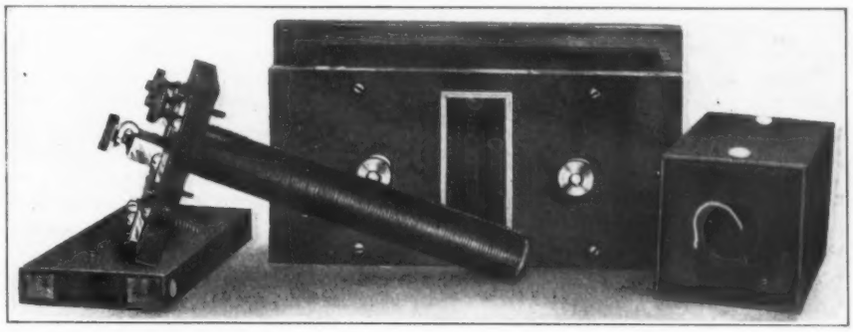


FIG. 1. PARTS OF CARTRIDGE JUMP-SPARK COIL

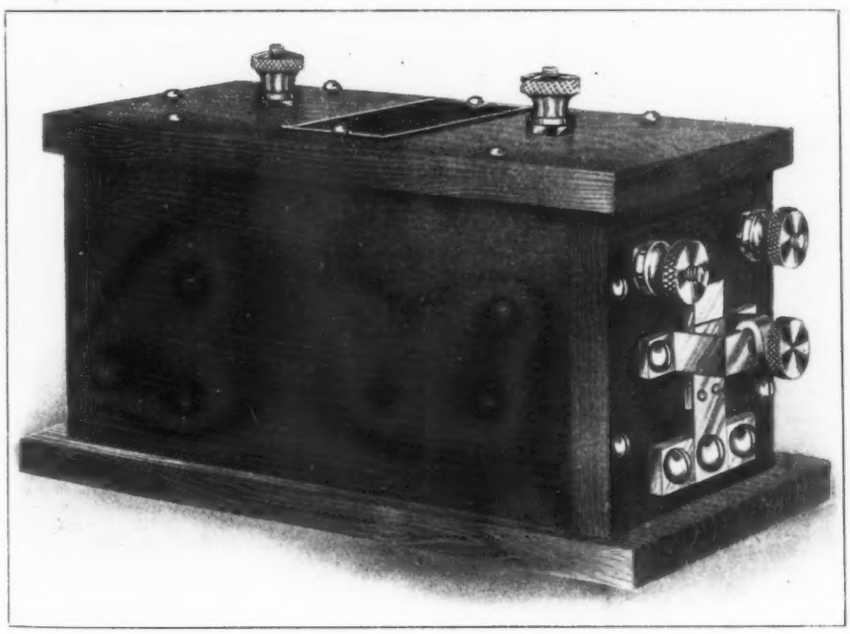


FIG. 2. JUMP-SPARK COIL IN CASE

The cartridges for these coils are vacuum treated while being boiled out in wax, and a high quality of insulating compound takes the place of moisture and air, hermetically sealing the coils and the condensers in their respective receptacles.

The coil windings are made of black enameled wire, which is used exclusively in place of cotton- or silk-insulated wire. The cartridge coil has a contact adjuster which gives an adjustment that cannot change of its own accord, but which requires no tools to change when desired. These coils are furnished in all sizes and for all requirements.

## The Oxalic Acid Hoax

The letter signed "Engineer" in *The Times* yesterday gave a perfectly comprehensible and lucid explanation of the saving in coal effected by school janitors last winter, who solemnly treated their burned-out cinders with doses of oxalic acid, salt, and water, in obedience to the order of the Committee on School Supplies of the Board of Education. The ridiculous fallacy of this practice has been proved by good authority. But the janitors, taking advantage of every mildness in the winter, and by careful stoking where they once used coal wastefully, did succeed in saving, according to Committeeman Frank D. Wilsey, of Kingsbridge, "from 10 to 70 per cent. of fuel in the school buildings." Knowing the "crotchet" of the committee, who warned them that they must show results with the oxalic-acid solution, for fear of losing their jobs they have not dared to betray the real cause of the accrued saving.

If Chairman N. J. Barrett wishes himself and his colleagues on the committee to be freed of a terrible suspicion that they do not exactly adorn a board of education, he had better procure, and as the Prayer Book saith, read, mark, learn, and inwardly digest, the published findings of Professors Stillman and Gill, of the Stevens and Massachusetts Institutes of Technology, and Professor Pellew, of Columbia University, concerning the efficacy of oxalic acid mixed with burned-coal ashes. Then they may procure, with clarity of mind and conscience, the dismissal next winter of those janitors who shall fall below this year's record in coal saving without any adventitious and superstitious aid from their acid prescription. —*New York Times.*

# Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

*Breaking Strain of Steel Wire Rope*

Please give the breaking strain of 11/16 plow-steel wire rope; also the safe load, and the rule.

A. G.

The breaking strain of 11/16 plow-steel wire rope, with seven wires to the strand, is given at 21 tons, or 42,000 pounds. The proper working load is given at 4 tons, or 8000 pounds. The breaking strength is determined by tests. The proper working load is determined by judgment, and may vary with the character of service and the permissible risk of breakage.

*Flickering of Incandescent Lamps*

The incandescent lamps supplied by a dynamo direct-connected to its engine flicker badly; the flickering seems to be in exact time with the revolutions of the engine shaft, occurring twice during each revolution. What is the cause?

J. L. D.

The engine fly-wheel is too light; consequently, the shaft surges forward each time steam is admitted and loses speed after each cut-off of steam. A heavier fly-wheel is the only remedy.

*Grounding Electrical Machine Frames*

Why are the frames of high-potential generators grounded and those of low-voltage machines insulated from the ground?

H. J. J.

High-potential machines are grounded on the frame in order to protect the attendants. Should the insulation of the armature winding of such a machine become sufficiently damaged to allow contact between the conductors and the core, an attendant touching the frame would form a path to ground and would doubtless be injured if the frame were not grounded. With a good low-resistance ground connection on the frame, there is no appreciable difference of potential between the frame and the earth, and touching it is not dangerous. A ground connection on any machine is objectionable because it provokes leakage, and it is used only where necessary to eliminate danger to persons.

*Computing Hight of Fracture of Flag Pole*

A flag-pole 100 feet high breaks off so that the top hits the ground 40 feet from the base. At what hight from the ground is the fracture?

R. S. W.

The product of the sum and the difference of two quantities is equal to the difference between the square of the sum and of the difference. In this case the pole broke into two segments, the sum of which is 100. In falling it made a right-angled triangle, the base of which is 40 feet. The square of this is $40 \times 40 = 1600$ feet. But the square of the base of a right-angled triangle is equal to the difference of the squares of the two other sides; in this case to the difference between the squares of the two segments into which the pole broke. Then the product of the sum and difference of the segments is 1600, and as the sum is 100 the difference is $1600 \div 100 = 16$. Then the lesser of the segments will be

$$\frac{100}{2} - \frac{16}{2} = 42$$

feet, and the pole broke 42 feet from the ground.

Proof: The sum of the squares of the two sides is equal to the square of the hypotenuse. The hypotenuse will be

$$100 - 42 = 58$$

feet.

$$42 \times 42 = 1764$$
$$40 \times 40 = 1600$$
$$58 \times 58 = 3364$$

Again, $C\,B = 40$ (see Fig. 1) is the tangent of the angle at $A$ to the radius $A\,C$, and would be $40 \div 100 = 0.4$ to a radius of unity. The table says this is the tangent of 21 degrees 48 minutes. Since $A\,D = D\,B$, the triangle $A\,D\,B$ is isosceles and the angles at $A$ and $B$ are equal, and their sum is equal to the smaller of the angles at $D$; for the sum of the three angles of a triangle is 180 degrees, the larger angle at $D$ will be $180 - (A + B)$ so that $A + B$ must be the smaller angle which completes the 180.

The sides of a triangle are proportional to the sines of their opposite angles. Then,

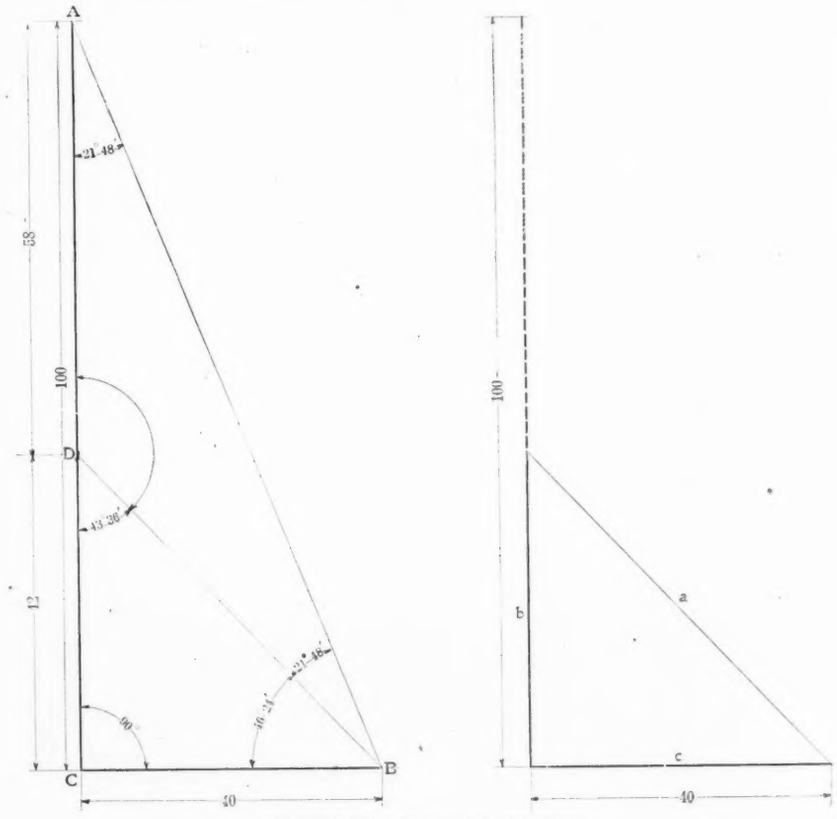
$$Sin\ D : C\,B : : Sin\ B : C\,D,$$

but $D\,C$ is the cosine of the angle at $D$ as well as the sine of that at $B$; so

$$Sin\ D : C\,B : : Cos\ D : C\,D.$$

Substituting the values given for the sine and cosine of 43 degrees 36 minutes in a table of trigonometrical functions, it is found that

$$0.6896195 : 40 : : 0.7241719 : 42.$$




DETERMINING HIGHT OF FRACTURE

Or again, call the segment above the break $a$ (Fig. 2), the segment below the break $b$, the distance from the base to the point at which the top struck $c$. Then

$$a = 100 - b,$$
$$a^2 = 10{,}000 - 200\,b + b^2,$$
$$a^2 - b^2 = 10{,}000 - 200\,b;$$

also,

$$a - b^2 = 1600;$$

then

$$10{,}000 - 200\,b = 1600,$$
$$10{,}000 - 1600 = 200\,b,$$
$$8400 = 200\,b,$$
$$b = 8400 \div 200 = 42.$$

# Book Reviews

DIRECT- AND ALTERNATING-CURRENT MACHINE DESIGN. By Francis B. Crocker and Theodore Forda. Published by McGraw Publishing Company, New York, 1908. Cloth; 450 pages, 6x9 inches; illustrated. Price, in one volume, $5; in two volumes, $3 each.

Self-instruction in the principles of dynamo design is the aim of the authors. The work is practically a collection of correspondence-school instruction papers, giving the fundamental principles of design and a list of examination questions at the end of each section. It is divided into two general parts, the one devoted to direct-current and the other to alternating-current design. These may be had separately or both in one volume.

The character of the work is good, bearing in mind the field for which the book is intended. The treatment of practical designing can scarcely be said to be up to date as to methods, but it is accurate technically, for the most part.

MATHEMATICAL HANDBOOK. By Edwin P. Seaver. Published by McGraw Publishing Company, New York. Cloth; 286 pages, 5x8½ inches. Price, $2.50.

While this book is only a compilation, the author deserves great credit for the skill and judgment displayed in his work. The book is divided into six parts: (1) Algebraic Formulas, (2) Formulas of Circular Functions and Trigonometry, (3) Hyperbolic Functions, (4) Differential and Integral Calculus, (5) Analytic Geometry, and (6) Tables. It is purely a reference book and as such it very nearly fills what has hitherto been a large void in mathematical literature. The formulas are arranged in logical sequence and cover practically all fundamental cases. The rule governing each case is stated and this is followed by the formula and its transpositions and variants.

The tables contained in the final section are those of powers, roots and reciprocals; common logarithms; binomial coefficients and factorials; hyberbolic logarithms; trigonometric functions, and logarithms of such functions; circular and volumetric relations; natural values of hyperbolic functions and their logarithms; numerical constants; weights and measures; and velocities of bodies falling from different hights.

THE STEAM TURBINE. By Robert M. Neilson. Published by Longmans, Green & Co., New York. Fourth edition, revised and enlarged. Cloth; 604 pages, 5¾x9 inches; 387 illustrations; tables; indexed. Price, $4.20.

One of the first works of any pretention upon the steam turbine was that of Robert N. Neilson, which appeared in 1902. The eager demand for information and the rapid development of the subject have resulted in the absorption of three editions of this work, each extensively revised, and the fourth edition, increased to a volume of more than double the size of the original, is now under review.

The author's aim has been to render the subject intelligible to the average engineer who has a fair but not necessarily a very extensive scientific training. His work commences with an easily-understandable explanation of the application of the velocity diagram to determining the relative velocities with which the steam enters and leaves the bucket, with the fundamental formula for the change of momentum and the work done. This is incidental to an exposition of the fundamentals and a setting forth of the definitions necessary to an understanding of the later chapters.

There follow 55 pages of historical account, enough to place the reader in touch with the development of the turbine and to turn the investigator from paths which have been already explored.

The third chapter, dealing with The Conversion of the Heat Energy of Steam into Kinetic Energy, is the most abstruse portion of the book and one of the few portions in which the calculus is used. It is a fairly clear presentation of the subject and leads to charts and formulas which place the reader in possession of the facts sought, even though he may not be able to follow their derivation. The author has abandoned the term "adiabatic" on account of its rather promiscuous use and has used the term "isentropic" to denote the mode of expansion which the rejected term is commonly employed to define.

The next chapter classifies and compares the various types of turbine, giving combined entropy-temperature and velocity diagrams of each type. The chapter upon the entropy diagram of former editions has been sacrificed in this to material more specifically a part of the subject.

Chapter V treats of Losses and Efficiencies. The "overall efficiency" is the ratio of the brake work to the total heat energy dealt with. The aggregate work done by the steam on all the buckets of the turbine has sometimes been called the "indicated work" because it corresponds to that shown by the indicator diagram of a piston engine. As the expression "indicated horse-power" is used in marine work in connection with a turbine in a different sense the author prefers the term "bucket work," which is certainly more specific and suggestive. The ratio of the aggregate bucket work to the total heat energy furnished is called the "thermal efficiency." The use of the term "indicated efficiency" for the ratio of the bucket work to the available heat energy is objectionable for the same reasons above noted and the term "efficiency ratio" recommended by the Institution of Civil Engineers in connection with piston engines is employed instead. The omission of $J$ in the denominator of the formula expressing this ratio (formula 3, page 113) is too obvious to be misleading.

The ratio of the jet kinetic energy to the heat energy available is called the "nozzle efficiency;" the ratio of the work done on a bucket to the jet kinetic energy, the "bucket efficiency;" the ratio of the work done on the buckets to the available energy of a stage the "stage efficiency;" the ratio of the brake or effective work to the available heat energy the "effective efficiency." For the ratio of the brake work to the aggregate bucket work the author suggests the term "rotation efficiency" as this takes into account the windage and friction losses due to rotation. In the two formulas on page 142 the 30 and 15 in the denominator should be 28 and 15.3 respectively. These various efficiencies are analyzed and for most of them the practical limits within which they lie are given. Seven chapters are then devoted to the description of existing types of turbine, not generally, but in detail. The effects of pressure, superheat and vacuum are then considered and a chapter devoted to electric generators as adapted to turbine drives. Some of the important turbine tests are recounted and a number of the notable turbine stations, both American and European, described. The concluding chapter treats of Ship Propulsion by Steam Turbines. Appendices contain tables of useful information and a complete list of British patents relating to turbines.

# Books Received

"Induction Coils." By H. Armagnat. McGraw Publishing Company, New York. Cloth; 216 pages, 5x8½ inches; illustrated; indexed. Price, $2.

"The Refrigerating Engineer's Pocket Manual." By Oswald Gueth, New York. Cloth; 156 pages, 4¼x7¾ inches; illustrated; indexed. Price, $1.50.

"Electric Power and Traction." By F. H. Davies. Van Nostrand Company, New York. Cloth; 293 pages, 5½x8¼ inches; 67 illustrations; indexed. Price, $2.

"Handbook of Mathematics for Engineers." By L. A. Waterbury. John Wiley & Sons, New York. Morocco; 91 pages, 2½x5½ inches; 61 illustrations; indexed. Price, $1.

"Practical Perspective." By Frank Richards and Fred H. Colvin. The Norman W. Henley Publishing Company, New York. Cloth; third edition; fully illustrated. Price, 50 cents.

"How to Become a Competent Motorman." By V. B. Livermore and J. R. Williams. D. Van Nostrand Company, New York. Cloth; 247 pages, 2½x6½ inches; 55 illustrations; indexed. Price, $1.

## Personal

Germain Hogan, a well known engineer, has been appointed superintendent of the metallic-packing department of the Monarch Steam Blower Company, of Troy, N. Y.

James C. McCabe has been appointed city boiler inspector at Detroit, Mich., and J. H. Williams his chief assistant. These were the highest and next highest on the list of competitors who took examinations for the purpose last month.

William G. Starkweather, for a number of years with the Allis-Chalmers Company, has opened a manufacturers' sales office for New England, at Boston, Mass., and will handle Corliss engines, Berry safety boilers and other power-plant apparatus.

Prof. Carl C. Thomas, latterly at the College of Agriculture and Mechanical Arts, West Raleigh, N. C., has joined the faculty of Columbia University, New York City, where he will take charge of a recently inaugurated course in machine design. This will be very agreeable news to Professor Thomas' friends, who will join in wishing him success.

## Obituary

Charles H. Dale, whose city home was at No. 131 West 119th street, New York, died at his summer home in Larchmont, July 18, from heart disease, after a brief illness. He was 56 years old. Mr. Dale was president and director of the Peerless Rubber Manufacturing Company, the Mechanical Rubber Company, the Morgan & Wright Company, of Detroit; the New York Belting and Packing Company, and the Rubber Goods Manufacturing Company, and a director in the General Rubber Company, the Hartford Rubber Works, of Hartford; the India-rubber Company, of New Brunswick, N. J.; the Indianapolis Rubber Company, of Indianapolis; the Mechanical Fabric Company, of Providence, and the Stoughton Rubber Company, of Boston.

## Business Items

The Rust Boiler Company, Pittsburg, Penn., in order to give better attention to its growing business in the East, has opened an office at 50 Church street, New York, in charge of R. M. Rust.

The Rust Boiler Company, Pittsburg, Penn., has sold to the Tennessee Coal, Iron and Railroad Company 11,000 horse-power of Rust boilers, for the Ensley plant. They are in part to replace old boilers with which the Ensley furnaces are now equipped.

J. B. Kane, who has had several years experience in the factory of the American Steam Gauge and Valve Manufacturing Company, has been promoted to the position of salesman and will make his headquarters at the New York branch of the company.

The Curtis & Curtis Company, Bridgeport, Conn., manufacturer of the Forbes patent die stock, announces that on July 1 it discontinued its office at 60 Centre street, New York City, and is now represented in that district by H. A. Williams, who will call upon the trade.

The State Board of Charities and Corrections of South Dakota has just awarded to the Minneapolis Steel and Machinery Company a contract for a 16x36 heavy-duty Twin City Corliss engine to be direct-connected to a 160-kilowatt a.c. generator. This outfit will be installed in the State Penitentiary at Sioux Falls, S. D.

The DuBois Iron Works, Du Bois, Penn., advises us that Robert R. Harkins, its representative at Cleveland, has associated himself with his father, Cass Harkins, formerly manager of the Atlas Engine Company, Columbus, O. The firm name will be Cass Harkins & Son, with offices at 1419 Schofield building, Cleveland, O.

The Pittsburg Steel Supply Company was recently appointed agent for the Pittsburg district representing the American Steam Gauge and Valve Manufacturing Company. The officers of the Pittsburg Steel Supply Company are all experienced men and have a thorough knowledge of the requirements of the manufacturing concerns throughout Greater Pittsburg.

At a meeting of the directors of the Dearborn Drug and Chemical Works, held at the general offices of the company on July 8, W. A. Converse, assistant secretary and chemical director of the company, was elected secretary and chemical director, and Ralph R. Browning, assistant treasurer, was elected treasurer. Both Mr. Converse and Mr. Browning have been connected with the Dearborn company for many years.

The Parker Boiler Company recently completed the third order from the Michigan College of Mines, Houghton, Mich., calling for one 268-horse-power unit. The college already has two 120-horse-power units, one installed in 1901 and the other in 1904. The Parker Company has also received an order from the United Verde Copper Company, Jerome, Ariz., for two 265-horse-power boilers equipped with superheaters, and an order from the Belen Mining Company, Sonora, Mex., for two 130-horse-power units.

The contract for the engines for the new power plant of the Bigelow Carpet Company, Clinton, Mass., has just been awarded through the office of Charles T. Main, engineer, Boston, to the Providence Engineering Works, Providence, R. I. It includes a 400-horse-power non-condensing and a 1000-horse-power compound condensing engine, both of the horizontal type. The awarding of the contract for the attached generators has been delayed. The complete units will be of 300-and 750-kilowatt capacity, respectively.

The Monarch Steam Blower Company, manufacturer of "Sterling" metallic packing, Troy, N. Y., announces that Germain Hogan has become interested with the company in the manufacture of the "Sterling" metallic packing for stationary and marine engines, ammonia and air compressors, steam pumps, etc. The packing which Mr. Hogan has been making successfully and marketing for the past ten years will be made under his personal supervision, thus assuring the same careful workmanship and selection of materials as in the past.

J. W. Lowell, Eastern manager of the Fort Wayne Foundry and Machine Company, has also been appointed manager of the Bass Foundry and Machine Company, which has taken more commodious offices in the American Surety building, 100 Broadway, New York. John Bass, president of the Fort Wayne Foundry and Machine Company, is also president of the Bass Foundry and Machine Company. By having combined the two offices under one management, Mr. Lowell has been put in a position to handle contracts for steam engines and boilers, or gas engines and producers. Prior to May 1 the office of the Bass Foundry and Machine Company was at 141 Broadway.

## New Equipment

The city of Lima, Ohio, will erect a municipal lighting plant.

The city of Fordyce, Ark., contemplates constructing water works.

The Paxton (Ill.) Electric Company is planning to install an ice plant.

The Valley Falls Company, Pawtucket, R. I., is building a five-story addition to cost $50,000.

Blake & Blake, El Reno, Okla., contemplate installing an alfalfa mill. Electric power will be used.

The city of Beaufort, S. C., voted $43,000 bonds to construct electric-light plant and other improvements.

It is reported that the Ft. Scott (Kan.) Gas and Electric Company will spend about $50,000 in improvements.

The City Council, Longmont, Colo., is considering the question of establishing a municipal electric-light plant.

The Perkins (Okla.) Electric Light and Power Company contemplates establishing a power service and installing an ice plant.

The citizens of Earlham, Iowa, voted to issue $17,000 bonds for the purpose of constructing an electric-light plant and water works.

It is said that the Corn Products Refining Company, Chicago, Ill., will erect a modern glucose plant to cost about $2,000,000.

The Aurora, Elgin & Chicago Railroad Company, of Chicago, Ill., has awarded contract for the construction of a sub-station at Elgin.

The Augusta-Aiken Railway and Electric Company will install a generator of about 350-horse-power in the Augusta, Ga., power house.

The Lacombe plant of the Denver (Colo.) Gas and Electric Company was damaged by the bursting of a fly-wheel, causing a loss of about $10,000.

The Ada (Okla.) Ice and Fuel Company has been incorporated with $10,000 capital stock. Will operate a 12-ton ice plant. H. D. Hamilton, president.

The Finance Committee of Richmond, Va., will issue about $350,000 bonds to construct electric plant and install additional pumps at new pump house.

It is reported that the Columbus (Miss.) Railway, Light and Power Company contemplates the installation of a 350-horse-power water tube boiler.

The Columbia County Cottonseed Oil Company, Harlem, Ga., has been organized to establish cotton-seed oil mill and electric-light plant. J. L. Weeks, president.

The Board of County Commissioners, Evansville, Ind., is considering the question of installing electric lighting systems in the white and colored orphan asylums.

The Northern Hydro-Electric Power Company, of Green Bay, Wis., is planning to erect a power plant at Peshtigo, Wis., which, it is said, will cost over $500,000.

About $750,000 will be spent by Kansas City, Mo., on improvements to water works, which will include new pumping engines. Wm. G. Goodwin, acting chief engineer.

It is reported that a central electric-light plant will be constructed at Danville, Va., at a cost of $150,000. Frank Talbot, superintendent water and light department.

It is reported that the United States Steel Corporation has secured land at Stinesville, Ind., on which will be erected crushing and refining mills, electric-light plant, etc.

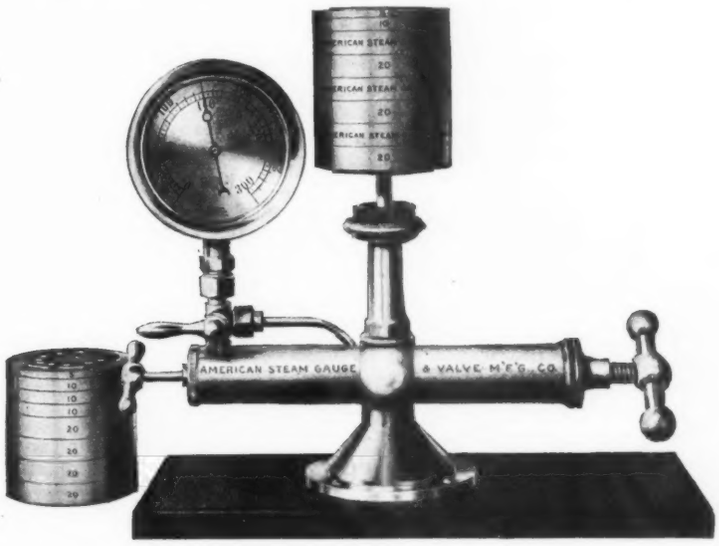
Engineers of the Utah Light and Railway Company, Salt Lake City, are preparing plans for a power plant to be built in the Weber Cañon at an estimated cost of $200,000

# Test Your Gauges

¶ HOW OBVIOUSLY MORE IMPORTANT it is to have a correct gauge than to have a correct watch.

¶ The ordinary steam gauge is subject to error in a manner similar to the average watch. When your watch is wrong you know it by comparing it with others, but when your steam gauge is wrong you are unconscious of the fact.

¶ Let your gauge register 20 pounds or more under the pressure you really maintain and it means enormous waste.




¶ With the AMERICAN DEAD WEIGHT TESTER you can test your gauges at frequent intervals and keep them accurate. It is a simple dependable instrument always ready for use and useful always. Tests are made with dead weights in five pound units and are furnished for any desired pressure up to 2000 pounds.

¶ It has all the advantages of the Mercury Column in a much smaller space.

¶ Our descriptive circular of this instrument will be sent on request.

If your jobber does not carry "The American" and will not procure them for you, we will ship to you direct from our factory.

## The American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex
Montreal, 444 St. James Street.

San Francisco, 247 Pine Street.
Los Angeles, 218 So. Los Angeles Street.

When ordering gauges, valves, indicators, and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us.
Your interests can be best served by the protection they afford.

## New Catalogs

Kewanee Boiler Company, Kewanee, Ill. Catalog. Boilers. Illustrated, 78 pages, 6x9 inches.

Acheson Oildag Company, Niagara Falls, N. Y. Catalog. Lubricant for gas engines, etc. 12 pages, 3½x6 inches.

C. O. Bartlett & Snow Company, Cleveland, Ohio. Catalog. Paint machinery. Illustrated, 32 pages, 6x9 inches.

Monarch Steam Blower Company, Troy, N. Y. Catalog. Sterling metallic packing. Illustrated, 40 pages, 6x9 inches.

The Berry Engineering Company, Chester, Penn. Catalog. Steam specialties. Illustrated, 48 pages, 5½x8 inches.

Whiting Foundry Equipment Company, Harvey, Ill. Foundrymen's reference book. Illustrated, 32 pages, 6x9 inches.

Buckeye Engine Company, Salem, Ohio. Catalog. Four-stroke cycle gas engine. Illustrated, 44 pages, 7x10 inches.

E. M. Carr Pump Governor Company, New Castle, Ind. Catalog. Steam pump governor. Illustrated, 12 pages, 3½x6 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 92. Recording thermometers, class II. Illustrated, 16 pages, 8x10½ inches.

Barco Brass and Joint Company, 56 North Jefferson street, Chicago, Ill. Catalog. Barco flexible joint. Illustrated, 16 pages, 6x9 inches.

Triumph Electric Company, Cincinnati, Ohio. Bulletin No. 341. Some Illustrations of Triumph Motor Drives. Illustrated, 32 pages, 6½x10 inches.

The Trill Indicator Company, Corry, Penn. Catalog. Triumph steam engine indicators and appliances. Illustrated, 32 pages, 6x9 inches.

Houchin-Aiken Company, 35-45 Fifty-third street, Brooklyn, N. Y. Catalog. Improved Law metallic packing. Illustrated, 8 pages, 3½x6 inches.

Standard Gauge Manufacturing Company, Syracuse, N. Y. Bulletin No. 1. Eclipse oil filters and continuous oiling systems. Illustrated, 28 pages, 8x10½ inches.

Empire Steel and Equipment Company, 141 Broadway, New York. Catalog. Automatic smoke preventer and fuel economizer. Illustrated, 16 pages, 5½x7½ inches.

R. B. Whitacre & Company, St. Paul, Minn. Catalog No. 1. Engine room and mill machinery, equipment and supplies, shafting pulleys, belting, etc. Illustrated, 260 pages, 6x9 inches.

The G. M. Parks Company, 453 Main street, Fitchburg, Mass. Catalog. Turbo-humidifier. Illustrated, 38 pages, 5½x8 inches. Catalog. Parko packings. Illustrated, 48 pages, 4½x6 inches.

Greene, Tweed & Company, 109 Duane street, New York. Catalog. Improved Rochester automatic lubricators, belt studs, belt couplings, wrenches, packing, etc. Illustrated, 112 pages, 6x9 inches.

G. M. Davis Regulator Company, 144-146 Milwaukee avenue, Chicago, Ill. Catalog. Pressure regulators, damper regulators, valves, steam traps, pump governors, etc. Illustrated, 80 pages, 5x7½ inches.

F. E. Keyes and Son, 20 Broad street, New York. Folder. Advance feed-water purifier, multicoil feed-water heater, Dean boiler tube cleaner, Diamond flue boiler. Illustrated, 4 pages, 3½x6 inches.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Salesmen on commission for New England, Southern and Western States for high grade shaking grates. Box 13, POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Salesman on commission for high grade power specialties. Address, stating experience, Chas. T. Luce Co., 160 Congress St., Boston, Mass.

WANTED—Master mechanic for iron mine in northern Michigan. Must have had good experience with all kinds of mine machinery and machine shop work. To an energetic, capable man a good position is offered. If requested communications will be confidential. Address "Iron," care of POWER, giving experience in detail, references and pay expected.

CASUALTY INSURANCE COMPANY invites applications for vacancy in Inspection Department from superintendents or foremen of manufacturing plants, having extensive experience in the erection and operation of machinery. Full details of experience, salary expected and references must be given to obtain consideration. Box 19, POWER.

WANTED—Successful young man of character, energy, ability and experience for sales-manager of concern with ample capital and facilities, located in growing Missouri river city, handling full line of engines, boilers, mechanical goods, mill supplies, belting, etc., and owning large machine shops. Fine opportunity for the right man. State age, references, experience and salary. Address Box 21, POWER.

WANTED—A man of first-class character in Southern and Western towns to represent POWER AND THE ENGINEER—to secure subscriptions on a very liberal commission basis. Only those considered who know the paper, believe in it and will work enthusiastically to book orders and get the cash. Commissions are to be deducted from moneys collected. We will help you all that we can with circulars and samples. Give the names of two people or firms (firms preferred) whom we can write to for references. Answer at once and be the first man from your town. Circulation Dept., POWER AND THE ENGINEER, 505 Pearl Street, New York City.

WANTED, AN ENGINEER—We handle all kinds of mechanical and electrical machinery; controlling the agencies of some of the best manufacturers in the United States and Canada for the province of Alberta and the Kootenay mining district in British Columbia. We have houses at Edmonton and Calgary, Alberta, and Nelson, B. C. We have a position open for an engineer who has practical experience in the above lines, and who also possesses ability as a salesman. This is a splendid opportunity for a capable young man wishing to get a start in the rapidly developing country of Northwestern Canada. Please state your age, experience, reference and salary required in your first letter. Address Gorman, Clancey & Grindley, Limited, Calgary, Alberta, Canada.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

POWER EXPERT wants connection with large power plant as supervisor or consulting engineer for betterment work. Box 20, POWER.

ENGINEER will pay $50.00 commission to anyone who secures or helps him secure a position as engineer, assistant engineer or station man in Rocky mountains West. Box 14, POWER.

ENGINEER wants position in northern Michigan or Wisconsin as assistant in large plant or chief in small plant. German (marine engineer), married, sober, reliable, references. P. O. Box 285, Woodbridge, N. J.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

DRAWINGS, designing special and automatic machinery, inventors' ideas developed by mechanical engineer of long experience. First class references. H. W. Cole, 453 Third St., Brooklyn, N. Y.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—The patent rights of one of the best steam traps and oil filters manufactured. A bargain if sold quickly. Parties reason for selling being the desire to retire from business. Box 85, POWER.

MACHINERY FOR SALE at the Kokomo, Indiana, works of the Pittsburgh Plate Glass Company. One L. H. 30x60 E. P. Allis girder frame Corliss engine, 24' fly-wheel; 1 L. H. 10x30 E. P. Allis girder frame Corliss engine, 12' fly-wheel; 1 G. F. Blake 9x20x12 duplex vertical air pump; 1 E. P. Allis vertical surface condenser, 2700 sq.ft.; 1 15x18 high speed piston valve Beck engine; 1 10x18x14 tandem compound self-oiling Fisher automatic engine; 1 14x10x12 Smith-Vaile duplex steam pump; 1 R. H. Rankin & Fritsch 14x20 Tangye frame slide valve engine; 1 L. H. Rankin & Fritsch 14x20 Tangye frame slide valve; 1 13x20 box bed R. H. Mansfield throttling engine; 1 12x20 box bed L. H. Mansfield throttling engine; 7 14x24 Atlas box bed slide valve engines L. H.; 7 14x24 Atlas box bed slide valve engines, R. H.; 1 Laidlaw-Dunn-Gordon 14x22x18 duplex air compressor; fly-wheel-type air cylinder, unjacketed; 1 Dean Steam Pump Co. 12x7x10 duplex pump, just out of repair shop; 1 6x4x6 Worthington duplex steam pump; 1 Dean Steam Pump Co. 10x6x10 duplex steam pump; 8 Cahill vertical water tube safety boilers, 250 h.p. each. Inquire about above of W. D. Hartupee, 2d Vice Pres., Pittsburgh Plate Glass Co., Frick Building, Pittsburg, Pa.

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# COCHRANE SEPARATORS

## THE MEANING OF REPEAT ORDERS

An improved appliance is not adopted universally in a day or in a year, but if you keep count year by year and see that it is gaining ground rapidly and steadily, the inference is pretty certain that it is doing good work, that each installation is bringing further orders to the manufacturer and that users are speaking a good word for the device and are sending in repeat orders.

Consider, then, the fact that over 12,000 Cochrane Steam and Oil Separators are in daily satisfactory use, that Cochrane Oil Separators are protecting over 8,000,000 H.P. of boilers from oil in exhaust steam and that concerns like the following have given repeat orders in the numbers indicated :

| | No. of Orders | No. of Separators |
|---|---|---|
| LACKAWANNA STEEL CO., | 14 | 69 |
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These few, selected from a large number of iron and steel plants, cover separators for a highly interesting variety of uses; enormous steam separators for rolling mill engines, receiver separators with large wells that take care of the pulsations of the engine, equalizing the flow of steam, thereby increasing the capacity of the piping, vertical, angle and special separators of every conceivable kind; separators designed to withstand superheat and severe pipe strains, exceptionally large castings and steel plate work, oil separators for pipes large enough to drive a horse through, protecting thousands of horse power of boilers from oil, and making possible the saving of millions of gallons of water and hundreds of tons of coal, etc., etc.

Let us give you other references, as many as you want, from Electric Light Plants, Street Railways, Steam Railroads, Collieries, Textile Mills, Cotton Mills, Irrigation Plants, Breweries, Ship Builders, Tanneries, Paper and Pulp Mills, Leather Manufacturers, Brass and Metal Manufacturers, Grain Elevators, Cement Mills, Metal Mines, Packing Houses, Gas Works, Coal, Oil and Chemical Manufacturers, Office Buildings, Hotels, etc., etc.

If you have any problem in connection with the removal of oil from live steam, or the utilization of exhaust steam, write for a copy of our Book "15-S" on Cochrane Steam and Oil Separators.

HARRISON SAFETY BOILER WORKS,

17TH & CLEARFIELD STS., PHILADELPHIA, PA.

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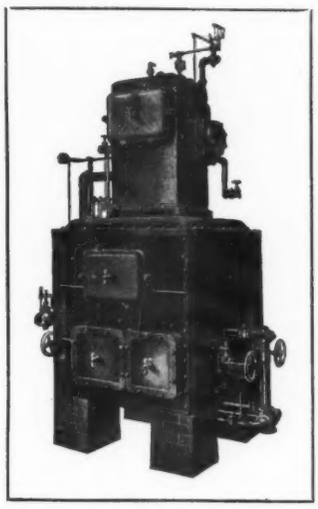

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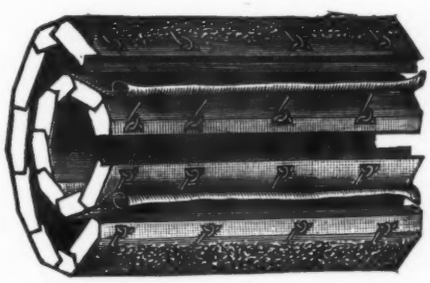

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Lunkenheimer Co., Cincinnati, O.
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Ft. Wayne Electric Works, Ft. Wayne, Ind.
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Northern Electrical Mfg. Co., Madison, Wis.
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Sturtevant Co., B. F., Hyde Park, Mass.
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Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.

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Reagan Grate Bar Co., Phila., Pa.

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Neemes Bros., Troy, N. Y.
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N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
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American Steam Gauge and Valve Mfg. Co., Boston, Mass.

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Schutte & Koerting Co., Philadelphia, Pa

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Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.

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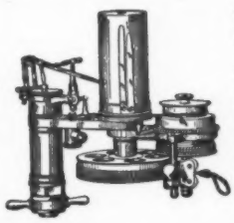

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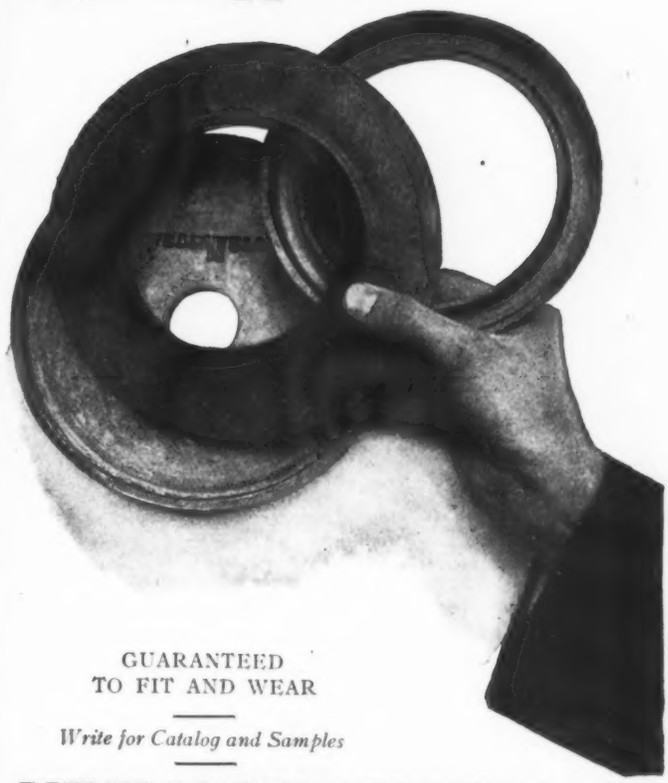

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PARIS FRANCE.-76 AVE DE LA REPUBLIQUE.
SYDNEY, AUSTRALIA.-270 GEORGE ST.
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**Specialties, Steam**

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
American District Steam Co., Lockport, N. Y.
Baragwanath & Son, Wm., Chicago, Ill.
Berry Engineering Co., Chester, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Ia.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Lippincott Steam Specialty and Supply Co., Newark, N. J.
Lunkenheimer Co., Cincinnati, Ohio.
McCrea & Co., James, Chicago, Ill.
Nason Mfg. Co., New York.
Ohio Brass Co., Mansfield, Ohio.
Patterson & Co., F. L., New York.
Penberthy Injector Co., Detroit, Mich.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Stephenson Mfg. Co., Albany, N. Y.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Phila., Pa.
Webster & Co., Warren, Camden, N. J.
Wheeler Cond. & Eng. Co., New York.

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Ohio Brass Co., Mansfield, Ohio.

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Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Borden Co., Canton, O.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., The, Cleveland, O.
Toledo Pipe Threading Machine Co., Toledo, O.

**Stokers**

Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Westinghouse Mach. Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

**Stokers, Mechanical**

McClave-Brooks Co., Scranton, Pa.

**Strainers**

Dean Bros. Steam Pump Works, Indianapolis, Ind.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.

**Superheaters, Steam**

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Parker Boiler Co., Phila., Pa.
Power Specialty Co., New York.
Providence Eng. Wks., Providence, R. I.
Whitlock Coil Pipe Co., Hartford, Conn.

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C. & C. Electric Co., The, New York.
Fort Wayne Electric Works, Ft. Wayne, Ind.
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Northern Electrical Mfg. Co., Madison, Wis.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Sherwood Mfg. Co., Buffalo, N. Y.

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Jenkins Bros., New York.
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McCrea & Co., James, Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Nason Mfg. Co., New York.
Ohio Blower Co., Cleveland, O.
Platt & Co., John, New York.
Reliance Gauge Column Co., Cleveland, O.
Schutte & Koerting Co., Phila., Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Phila., Pa.
Williams Valve Co., D. T., Cincinnati, O.

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Crosby Steam Gage & Valve Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Jenkins Bros., New York.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Ohio Brass Co., Mansfield, Ohio.
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Lagonda Manufacturing Co., Springfield, O.
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**Valves, Automatic Relief**

Walch & Wyeth, Chicago, Ill.

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Jenkins Bros., New York.
Pittsburg Valve Foundry and Construction Co., Barberton, O.
Walch & Wyeth, Chicago, Ill.

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Williams Valve Co., D. T., Cincinnati, O.

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Power Specialty Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
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Walch & Wyeth, Chicago, Ill.

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Williams Valve Co., D. T., Cincinnati, Ohio.

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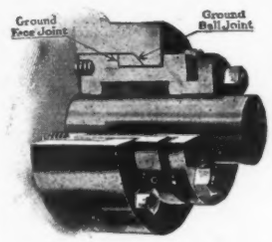


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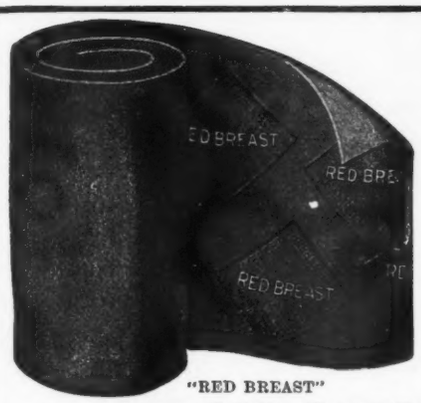


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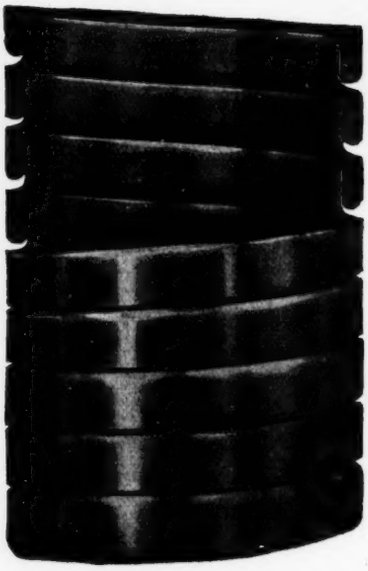

is perfectly secure for high pressures and for all liquids, compressed air, steam, gases, ammonia, oil, etc., etc.

It is made of copper or galvanized steel tape rolled in spiral form from one continuous length.

Note how the edges interlock and enclose the asbestos thread.

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He's got the ships, the cash, the men,
He's got *Black Squadron* too;
So, over there, they'd best beware,
The old *Red, White,* and *Blue.*

## BLACK SQUADRON
(THE ORIGINAL SLIDING WEDGE PACKING)

Gives greatest rod pressure, with least friction. Cannot carbonize and score the rod. Remains pliable under all conditions. Will not "melt away" in the stuffing box. Outwears all others.

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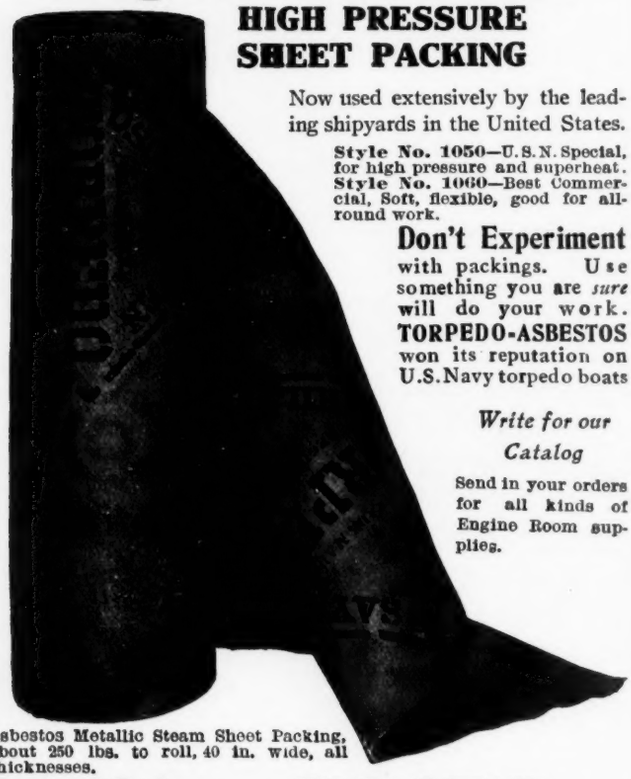

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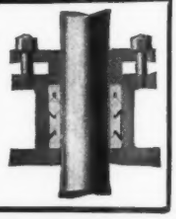

has a frictional bearing on the rod for only part of the stuffing box depth. BOOKLET ?

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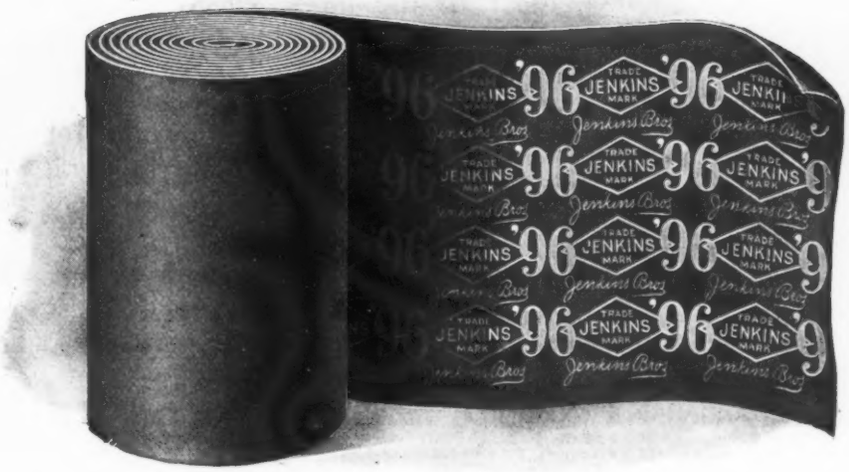


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**will pack the most uneven surfaces, making absolutely leakless, durable joints.**

**The pressure and heat cause the packing to vulcanize, fill up inequalities of surface and afford a fit as perfect as would be possible on the smoothest surface.**

**The Jenkins '96 is easily and quickly applied in either hot or cold joints. WRITE.**

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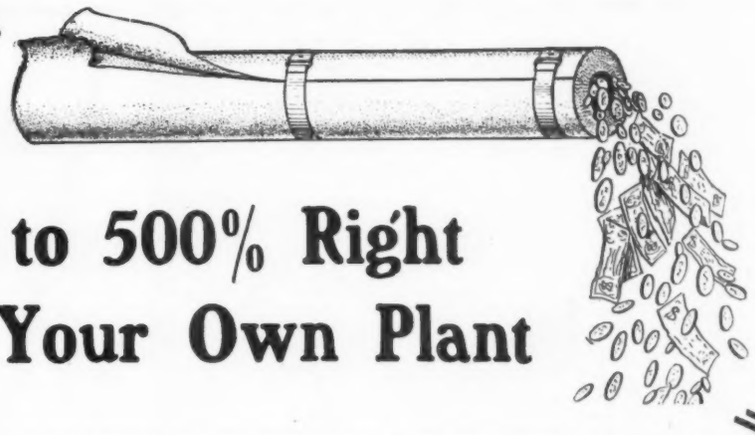

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# Paying 30 to 500% Right In Your Own Plant

That is the kind of investment J-M HIGH PRESSURE PIPE COVERING is, according to report made to the American Society of Mechanical Engineers by Mr. Geo. H. Barrus, a well-known engineer, giving the result of a series of tests made by him.

This report showed that when bare steam pipes were covered with J-M HIGH PRESSURE COVERING, a saving of 85% in coal was effected, which means a saving in fuel equivalent to a dividend of 518% a year on the cost of the covering. It also showed that when pipes formerly covered with ordinary high pressure covering were re-covered with J-M HIGH PRESSURE COVERING, a saving of 26% in coal was made, or what would figure a 31% yearly dividend on the investment.

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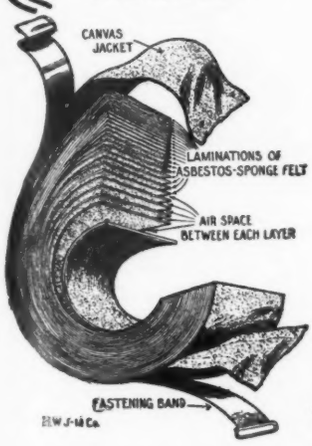
## J-M HIGH PRESSURE PIPE COVERING

Then think of how much easier it would be for you to keep up steam, and how much less coal would have to be shoveled if the pipes were properly insulated. Also think of the difference it would make in the temperature of the engine room on a hot day. J-M HIGH PRESSURE PIPE COVERING has reduced the temperature of many engine rooms 50 to 70 degrees—and many of these were engine rooms where pipes were previously *supposed to be* properly insulated.

No matter what ordinary pipe covering is now on your pipes, we can show you that J-M HIGH PRESSURE PIPE COVERING will save about ⅓ of the fuel you are now using, as well as reduce the temperature of the engine room.

If you want us to inspect your plant and make a recommendation for improving the insulation, drop us a card. It won't cost you anything for our opinion.

ASBESTO SPONGE FELTED PIPE COVERING

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## H. W. JOHNS-MANVILLE CO.

**Manufacturers of Asbestos and Magnesia Products, Asbestos Roofings, Packings, Electrical Supplies, Etc.**

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(843-1)

Ambest
TRADE MARK

## NO TROUBLE

for this engineer to pack a piston rod; he's using **Ambest** the new and practical metallic packing.

Ambest is composed of long pliable strands of non-friction metal, lubricated with a special mineral compound. The result is a packing as frictionless as oil. To apply it, twist the strands into a rope of as large diameter as can conveniently be inserted into the stuffing box, and jam the box full. Then screw the gland down tightly. Easy—isn't it?

### Some Advantages of Ambest

Any size rod or stem can be packed from the the same can.
It stands highest pressure and speed.
Cannot under any circumstances injure a rod.
Stands years of severe service.
Can be used over and over again.
Will stand 600 F. without fusing.
Is easily and immediately removable if desired.
Is the *only perfect* Ammonia Packing.

### FREE

If you want a sample, fill in and mail to us the coupon below:

CANFIELD MANUFACTURING CO.,
Philadelphia, Pa.

Gentlemen:—Kindly send me, free, a sample of Ambest Metallic Packing.

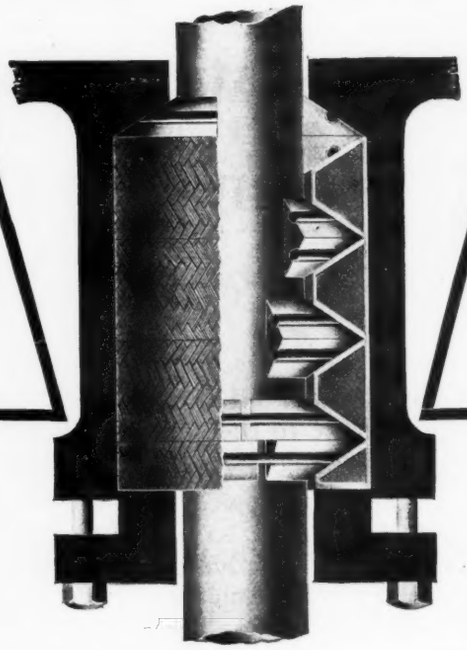
Name .....

Name of Firm .....

Address .....

Number and Total H. P. of Engines .....

**CANFIELD MANUFACTURING CO.**
**PHILADELPHIA, PA.**



# STERLING
## METALLIC PACKING STEADIES THE ROD
AND VALVE STEMS.

Note those rings. Each is a valve seat in itself; divided into three parts. The whole is elastic and works easily. Held to the rod by springs.

Sterling Metallic Packing adheres to the rod just enough to steady it and not enough to wear it. Friction is reduced, the rod is kept smooth and but little lubrication is required. If properly used, Sterling Packing will last as long as the engine. We guarantee to pack any type of steam engine or pump without altering the stuffing boxes. Illustration shows our steam packing design for piston rods for upright engines.

We also make Ammonia Packing. Write for catalog.

## MONARCH STEAM BLOWER COMPANY
TROY, N.Y.

# BELMONT
## "1903" EXPANSION PACKING
### For Steam and Ammonia

Pat. Feb. 24, 1903.

See the sliding wedge ?

When you place a ring in the stuffing box pull the ends of one wedge ahead of the casing ends, and push the other one back, then when the ring is closed and ready for service the joint is divided into three breaks, occurring at different points on the circumference. This feature enables one ring of **Belmont 1903 Expansion Packing** to stop steam as effectively as three rings of ordinary packing, and makes it especially valuable for shallow stuffing boxes. Material throughout is the best obtainable, and **Belmont 1903 Expansion Packing** (fully described in booklet A) is guaranteed for any service with steam or ammonia up to 125 lbs. pressure. Above this pressure our "high pressure" packing (write for booklet B) is to be preferred. *General Catalog on Request.*

**FREE!**

Send for a sample ring and be convinced.

CLEMENT RESTEIN CO.,
Philadelphia, Pa.

Gentlemen:—
Send me a sample ring of Belmont 1903 Expansion Packing

Name.....

Address.....

Firm Name.....

Number of Engines.....

Number of Pumps.....

Number of Boilers.....

High or Low Pressure.....

Packing now in use.....

Power, 7-28-08.

**CLEMENT RESTEIN COMPANY**

**133 North Second St. PHILADELPHIA, PA.**

# Five Different Packings

**Eureka Gum Core (the kind you know), Eureka Cut Ring, High Pressure, Water Proof and Red Sheet Packings. Do you know them all?**

THIS LABEL ON PACKING "EUREKA" TRADE MARK. IS A GUARANTEE OF EXCELLENCE.

## Cut Ring and in Spiral Form

Made to measure for any size rod and stuffing box. Guaranteed highest quality.

## High Pressure in Coils and Rings

is practically indestructible, as it is not affected by pressure or heat.

## Water Proof in Coils and Rings

is invaluable for all cold water purposes, such as pump pistons, hydraulic elevators, etc.

## Red Sheet

makes a perfectly tight joint on steam, gas or ammonia connections.

*Prices and Delivery will interest you.*

*Write for them.*

**Eureka Packing Company**

**Jas. L. Robertson, President**

**46 Warren Street, NEW YORK**

OXOILOX

will make any belt pliable and tough.

It drives out the old sticky dope that never can do any good, and restores to leather the natural strength and vitality lost in tanning.

OXOILOX is a leather food and preservative, not a drug.

All it does is to keep leather soft and strong and tough, so that it clings closely to the pulleys. But that is the whole theory of correct belt practice. Belts should cling so closely to pulleys that air is excluded from between the two surfaces. The partial vacuum thus formed makes slipping almost impossible and enables belts to do their full duty running slack.

OXOILOX is Nature's remedy for slipping belts.

FREE

F. S. WALTON CO., Philadelphia, Pa.

Gentlemen:—Kindly send me, free of charge, a Sample Can of OXOILOX, the perfect belt dressing.

Name .....

Name of Firm .....

Address .....

Number of belts .....

Average size .....

**F. S. WALTON CO.,** PHILADELPHIA, PA.

PRESSERS AND REFINERS OF ALL GRADES OF NEATSFOOT OIL.

**Durable, Reliable, Noiseless**

The Akron Friction Clutch picks up the load gradually without shock or jar, is easily installed, adjusted and operated. Write.

**The Williams Foundry & Machine Co.**

Successors to the Akron Clutch Co. AKRON, OHIO.

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MANUFACTURERS OF
**GILBERT WOOD SPLIT PULLEYS.**
New York Branch, 88 Warren Street.
Chicago Branch, 32 South Canal Street.
Sales Agencies in all principal cities.
Cable Address, "Engrave" A. B. C. and Lieber's Code.

**MOUND TOOLS. FOR THE ENGINE ROOM.**
This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.
No. 20 Set of 20 Tools . . . $4.00.
Book "Engineers' Chums" free. Address Dept. B
**MOUND TOOL AND SCRAPER CO.**
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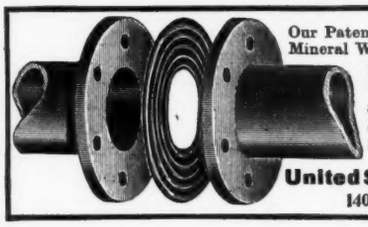
**THE PHOSPHOR BRONZE SMELTING CO., Limited.**
2200 WASHINGTON AVENUE, PHILADELPHIA, PA.
ELEPHANT BRAND "Phosphor Bronze"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, Etc.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U. S.



Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

**United States Mineral Wool Co.**
140 Cedar Street, New York

**WATER PROOF GEM BELT**

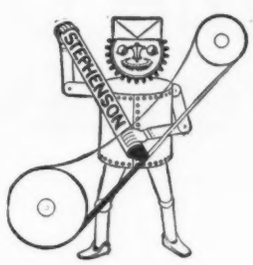
Not affected by water, steam, oil or gas.
A demonstrated success.
Small samples for test and full information to those interested by inquiring of

**JEWELL BELTING COMPANY**

**Main Office and Belt Factory:**
**HARTFORD, CONN.**

**Branches: NEW YORK PHILADELPHIA CHICAGO**

SAMPLES SPEAK LOUDER THAN WORDS




**And there is no string** to this method of selling our

STEPHENSON
Bar Belt Dressing

**Send us 2c. for testing Sample, and say which:**

**Red Label for Leather belts.**
**Green Label for Rubber or Canvas.**
**No one kind is good for all belts—**
**you know that.**

**Of Dealers Everywhere, or**

STEPHENSON MFG. CO.
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Agents for England:
**J. B. Stone & Co., Finsbury Pavement, London.**

## Jeffrey Coal Handling Machinery

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Sugar Refinery

Capacity for handling 120 tons of coal hourly.

Bulletins B and C—free with catalog on elevating, conveying, screening, crushing, mining and drilling machinery.

**The Jeffrey Mfg. Company**
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We can elevate or convey your **COAL** a distance of 100 feet for less than **ONE CENT A TON**
in quantities of ONE TON A MINUTE or more.

**Catalog Free.**

**THE C. O. BARTLETT & SNOW COMPANY,**
**Cleveland, Ohio.**

RHOADS LEATHER BELTING

*Built for Service*

*J. E. Rhoads & Sons*

PHILADELPHIA 12 N. THIRD ST. BOSTON NEW YORK 40 FULTON ST.
HAMBLET & HAYES CO. EASTERN AGENTS, 105-111 SUMMER ST.
FACTORY, WILMINGTON, DEL.

## Shultz Aqua Waterproof Belting

will do your work and do it right in damp places, or where exposed to steam

Aqua leather as well as the cement is absolutely impervious to surrounding conditions The plies won't separate from moisture.

OIL-STEAMPROOF "Aqua" WATERPROOF

**Tell us your belt troubles. Get an Aqua Belt for 60 days free.**

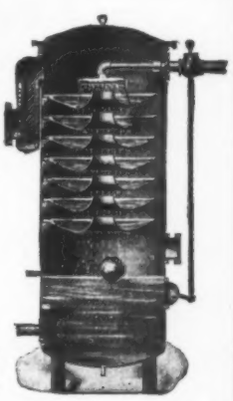
**SHULTZ BELTING CO.**
**ST. LOUIS, MO.**

NEW YORK BOSTON (26-A) PHILADELPHIA

## The Wickes Heater

Exhaust steam utilized for heating water for boiler feed or laundry work.

Simple, effective, durable. Tested like a boiler.



**The Wickes Boiler Co.**

MAIN OFFICE AND WORKS:
Saginaw, Michigan

SALES OFFICES:
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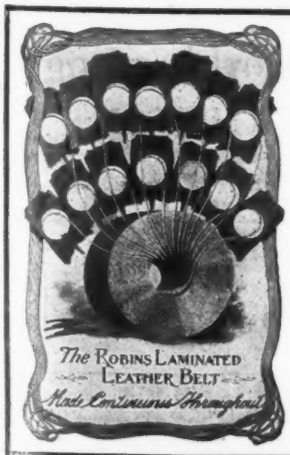
Penobscot B'ld'g, Detroit, Mich. Empire B'ld'g, Pittsburg, Pa.
601 Brown-Marx B'ld'g, Birmingham, Ala.




# Robins Laminated Leather Belting

*Eliminates The Glue Pot*

SOLVES THE BELT PROBLEM.

*The Scientific Principle:*

Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.

*The Positive Result:*

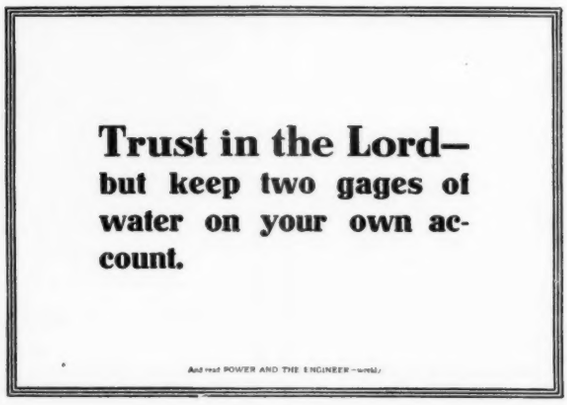
A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.

*Write for Circular No. 2 giving detailed description.*

**ROBINS NEW CONVEYOR COMPANY**

*NEW YORK,* **38 Wall Street.**
*FACTORY,* **168 Duane Street, N. Y.**
*CHICAGO,* **Old Colony Building.**

# Mottos for the Engine Room Given Away




ABOVE is one of them. Eight all told. Everyone is snappy, appropriate, original. Well printed on heavy paper, 11 1-2 x 8 1-2 in size. Just the thing to have in *your* engine-room.

*You may have the full set of eight mottos free and postpaid if you will renew your subscription to Power and The Engineer at once.*

They go FREE to all *new* subscribers, too. Get busy everybody and get the mottos. Never mind when your subscription expires. Send your renewal order *now*, to date from the expiration of your present subscription. And you, Mr. Non-Subscriber, slip $2.00 in an envelope, give us your name and address and we'll send you the mottos at once and keep the best power plant paper in the world going your way every week for a year.

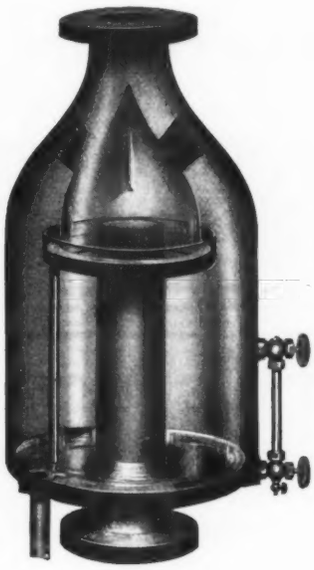
*All orders must bear the request, "Send me the mottos."*

**POWER** AND THE ENGINEER *505 Pearl Street, N. Y.*

*Published weekly at $2.00 a year in the U. S. and possessions, $3.00 in Canada, $4.00 Foreign.*

# HOPPES STEAM SEPARATORS

*have a principle of their own. Troughs partly filled with water* intercept the entrainment and same is carried to the bottom of separator by drain pipe as shown in cuts. Hoppes Separators are of *most ample proportions* and afford a large reservoir of steam near the cylinder of engine, giving a high initial pressure on the piston and preventing vibration in the steam line. Their *large receiver capacity* also enables them to take care of heavy flushes of water due to priming which so frequently wreck engines.



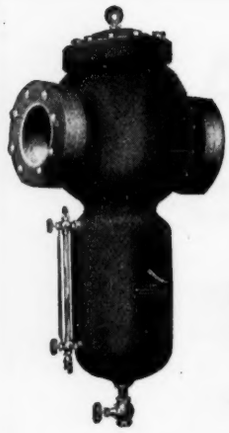
Hoppes Separators are built in both Cast Iron and Steel Shell types, the former in Horizontal and Vertical pattern, sizes 1" to 9" inclusive, the latter in all sizes and of design to suit conditions. We make a specialty of Steel Shell Separators of large receiver capacity and are prepared to bid promptly on specifications for this style of separator. Workmanship, material and efficiency *guaranteed.*

**LIVE STEAM FEED-WATER PURIFIERS,**
**EXHAUST STEAM FEED-WATER HEATERS,**
**OIL ELIMINATORS, - EXHAUST HEADS**

**WRITE FOR CATALOG**

## HOPPES MFG. CO.,

**19 LARCH STREET, SPRINGFIELD, OHIO.**



# Steam AND Oil Separators

"LOEW" Separators guarantee the highest efficiency and the greatest economy.

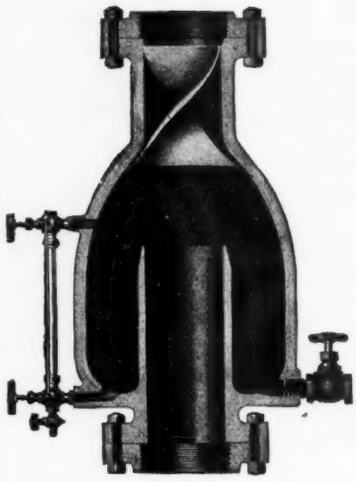
The Steam Separator insures dry steam to the cylinders and prevents engine troubles; reduces fuel bills and adds to the efficiency of the engine.

The Oil Separator is self-cleaning and will not clog. Its original efficiency is retained for an indefinite period.

Catalogs mailed on request.

**THE LOEW MANUFACTURING CO.**
CLEVELAND, OHIO.

# DON'T BE ABRUPT



in changing the direction of the steam as it flows through an exhaust head or separator. The penalty for this incivility to the steam will be paid in loss of pressure. You can only avoid it by extending courtesy through the use of

**DIRECT FLOW**

apparatus which doesn't abruptly disturb its flow. This apparatus of the well known

**SWARTWOUT TYPE**

is only manufactured by

**The OHIO BLOWER CO.,**
**CLEVELAND, OHIO.**

"STANDARD ENGINEERING CO., Toronto, Ont., exclusive licensees and manufacturers for the Dominion of Canada.

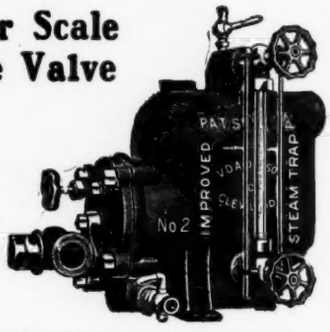
8-A

## No Sediment or Scale Can Reach the Valve

of Anderson's Improved Steam Trap.

Consequently you can always depend upon it to discharge without loss of steam.

*Get the "Trap Book," it's free.*




**THE V. D. ANDERSON CO.**
1935 West 96th Street, CLEVELAND, OHIO

# CUT THIS OUT

And file for reference. Or, better still, write today for circulars of **The GEIPEL STEAM TRAP.**

Made in Seven Sizes and for All Pressures.

**JOHN PLATT & COMPANY**
97 Cedar Street NEW YORK

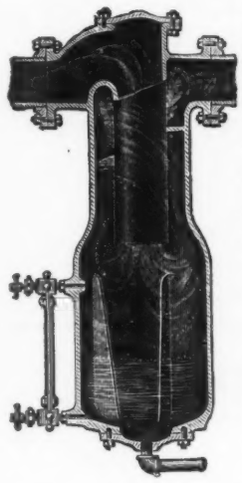
# KITTS SPECIALTIES
## Are Standard

**Steam Traps**
**Reducing Valves**
**Safety Water Columns**
**Low Water Alarms**
**Low Pressure Boiler Feeders**
**Vacuum Pressure Reducing Valves**
**Pump Governors**
**Fan Engine Regulators**
**Damper Regulators**
**Safety Feed Water Regulators**

**CATALOG?**

**Kitts Manufacturing Co.**
OSWEGO, N. Y.

## OF WHAT USE ARE BAFFLE PLATES



in a separator anyway?

They don't arrest the water when it comes in a rush except to break it into fine particles that are the more easily carried off with the steam

Therefore the

**STRATTON SEPARATOR**

has none of them.

It throws the water out of the steam by centrifugal force and lets only the pure dry article pass to the engine.

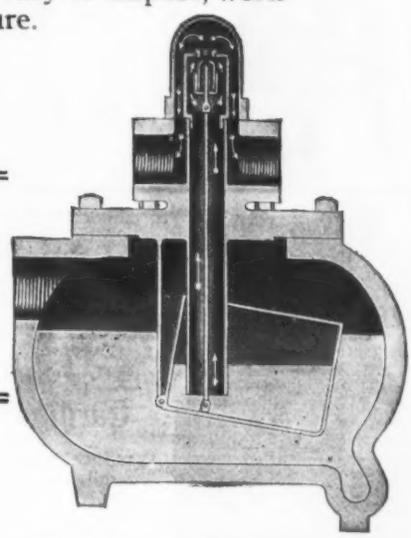
The STRATTON always does the work when others fail.

**Goubert Manufacturing Co.,**
**No. 90 West Street,**
**NEW YORK CITY, N. Y.**

## 4/S STEAM TRAPS

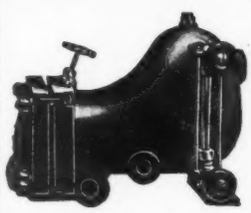
Don't get out of order, have great capacity, are easy to inspect, work at any pressure.

SEND FOR OUR CATALOG "A" TODAY.



**The Strong, Carlisle & Hammond Co.**
**342 Frankfort Avenue, CLEVELAND, OHIO.**

261 Centre Street, New York. 54 No. 6th Street, Philadelphia. 88 Broad Street, Boston.



## McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

## Watson Steam Pump Governor

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

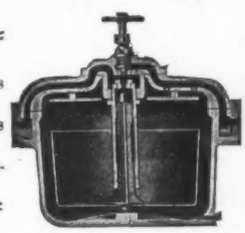
All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

*Send for Catalogue.*

**Watson & McDaniel Co.,**
**148 North 7th Street, Philadelphia, Pa.**

## Nason Manufacturing Company's STEAM TRAPS

**SPECIFY:**
Class B for pressures less than 20 lbs.
Class C for pressures 20 to 70 lbs.
"Sidelue" for pressures 40 to 150 lbs.



**THE TRAP THAT ALWAYS "FILLS THE BILL"**

## Nason Manufacturing Company's "Immersed Valve" Boiler Feeder

**FOR LOW PRESSURE STEAM BOILERS**

As a safeguard against the destruction of boilers through careless handling they are a necessary adjunct. Special Catalog.

**NASON MANUFACTURING COMPANY**
**71 FULTON STREET, NEW YORK**

# Harrisburg Feed Water Heaters

Of Pure Seamless Copper Coils. Guaranteed to be the most effective, most durable and cheapest heater manufactured.

*Please write for Descriptive Catalog.*

**COPPER, IRON AND BRASS PIPE COILS AND BENDS OF ANY DESIRED SHAPE**

**Manufactured by**

**The Harrisburg Pipe & Pipe Bending Co.**

**950 HERR STREET, HARRISBURG, PA.**

Manufacturers of HIGH GRADE

**Wrought Iron**

**PIPE**

**BLACK AND GALVANIZED**

## Greater Power At Reduced Cost

by keeping water from the cylinders and oil from the boilers.

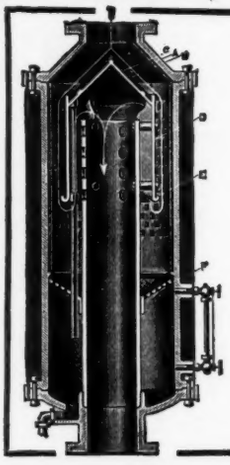
**Gardner Separators**

reduce the chances of accident, cut down fuel and repair bills and in other ways help the engineer.

*Catalog?*

**The Gardner Governor and Separator Co.**

**Quincy, Illinois.**



## DON'T

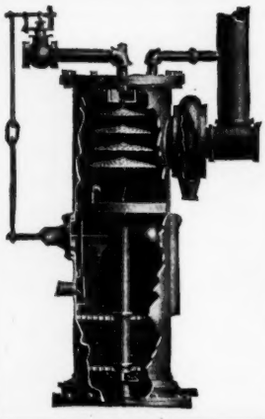
buy a steam or oil separator without sending for catalog describing

**SWEET'S**

and then *read* and *think* about it and you'll order one: 6000 in use; deliver steam 99.8 dry; takes out all the oil, that is 99%.

**DIRECT SEPARATOR COMPANY**

712 South Geddes Street SYRACUSE, N. Y.



## OUR TWINS

EITHER ONE WILL SAVE 15% of fuel and preserve the boiler.

*Write for Prices, Etc.*

**The Sims Co.,**

ERIE, PA.

Branch Office:
136 Liberty St., New York,
Tel., 539 Cortlandt.

## BAUM SEPARATORS

**ARE BEST for Live and Exhaust Steam.**

**Positively Guaranteed.**

"I take pleasure in stating that this department has used the Baum Separators for a considerable time, and has found them to be all you claim for them and are satisfactory in every respect." —The Superintendent of Public Buildings, Albany, N. Y.

*Send for new Catalogue and prices.*

**Hershey Machine & Foundry Co.**

85 Water Street, Boston, Mass.
MANHEIM PA., U. S. A.

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

These samples from a well-known New England plant show how a

**BLACKBURN-SMITH FEED-WATER FILTER AND GREASE EXTRACTOR**

turns dirty water or condensed exhaust into good boiler feed.

The first sample contains traces of oil, rust, and other dirt from the heating system. The second, which is as clear as crystal, was taken after running the feed through our 2-in. filter at boiler pressure of 100 lbs. and temperature of 225° F.

It pays to save and filter the condensation. You don't have to buy as much water, you keep scale-forming matter out and you reduce repair and coal bills by putting into the boiler pure hot water which would otherwise go to waste. *Write for treatise, "Feed Water Filtration."*

**JAMES BEGGS & CO., 106 Liberty St., New York**

16

REILLY MULTICOIL

## The Reilly Multicoil Feed Water Heater

**High Efficiency** on account of long travel of water through the coils; thorough agitation of water, therefore rapid absorption of heater; the scouring of the inside of tube walls caused by the centrifugal force of the flow **prevents scale accumulation** in the coils.

**Every coil a spring,** no temperature strains.

All tubes secured to headers with ground union joints.

Accessibility to interior parts through large door in the shell, without disconnecting pipes.

Tubes all standard and may be replaced by the engineer, using no other tool than a wrench.

Sizes: 30 H. P. to 6000 H. P.

*Write for Catalog.*

**THE GRISCOM SPENCER COMPANY**
**General Offices: 90 WEST ST., NEW YORK.**

REILLY MULTICOIL

## Piping Hot

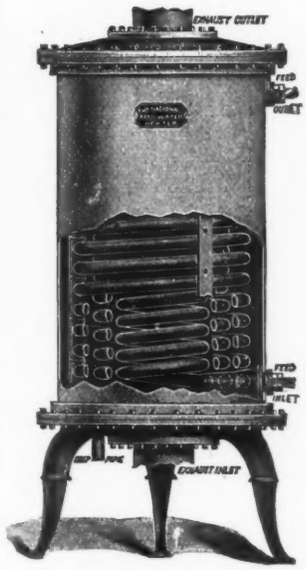
The Otis Feed-Water Heater, Oil Separator and Purifier is guaranteed to heat the feed-water to 210-212° F. with the exhaust steam. Its seamless brass tubes retain their heating qualities for an indefinite period. It's a case of **piping hot.**

For eliminating scale and removing oil, the "Otis" has no equal.

*Write for our twelve strong guarantees.*

**The Stewart Heater Co.,**
**45 E. Delavan Ave., Buffalo, N. Y.**

## BACK PRESSURE IMPOSSIBLE




as the shell area of

**A NATIONAL FEED WATER HEATER**

is from six to ten times that of the exhaust pipe.

2,5000,000 H.P. in use.

*Write for our catalog.*

**The National Pipe Bending Co.**
**175 LLOYD STREET, NEW HAVEN, CONN.**
**120 Liberty Street, New York** **54 High Street, Boston, Mass.**

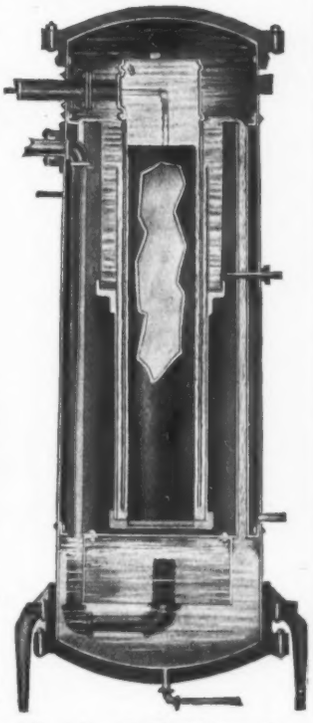
## A Written Guarantee

To increase boiler capacity while reducing fuel costs goes with every

**Eclipse Feed Water Heater and Purifier**

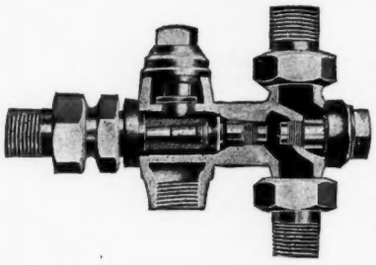
These results are secured by elimination of scale and prevention of foaming.

*Write for full particulars.*



**The Eclipse Feed Water Heater & Purifier Co.**
**Oshkosh, Wisconsin.**

## The Desmond Automatic Injector
## The Acme Of Simplicity



As far superior to the old style complicated Injectors as modern machinery is to that of a Generation ago.

Every one fully guaranteed. Accept no out-of-date substitute. Insist upon the DESMOND. Write for Catalog.

**The Desmond-Stephan Mfg. Company,**
**Urbana, Ohio.**

## THE HOT WATER CURE
**FOR BOILER TROUBLES**

will enable you to get the greatest possible profit from your steam with a minimum expense if you install the

## Patterson-Berryman Feed Water Heater

This heater differs from others in that it not only delivers hotter water at less expense but also removes all the scale-forming impurities. We will send you one on trial.

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**28 Cortlandt Street, New York, U.S.A.**

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Branches—New York, Chicago, San Francisco.

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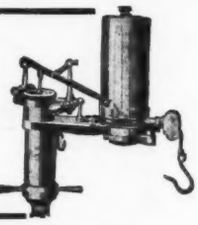

**$50 Cheaper Than any Other High Grade Indicator**

*CATALOG?*

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The construction of the Morehead Steam Trap is the simplest ever devised. As gravity is the motive power its operation is as reliable as that of any law of nature. *Descriptive catalog on request.*

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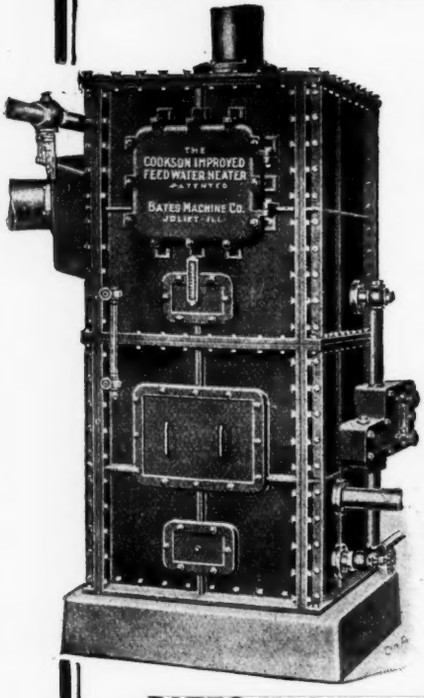


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Perfect Separation and Removal of Oil.

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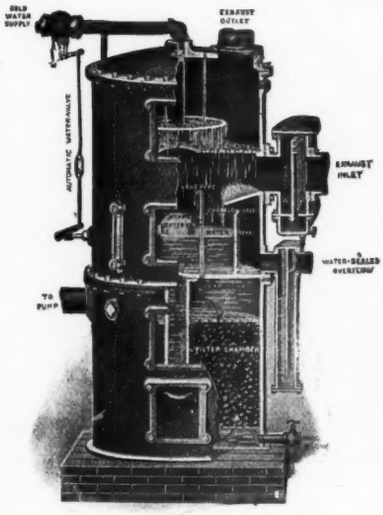
## THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier




**Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.**

**Manufactured by**

**THE WHITLOCK COIL PIPE COMPANY**
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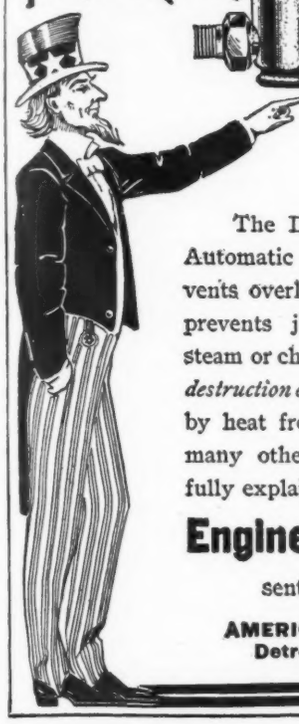
New York Office—Singer Building, 85 Liberty Street.

# No Freezing Here

The Drip Cock prevents it

U.S. Automatic Injector



The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

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**Detroit, Mich., U. S. A.**

**A Powerful Little Device for Elevating, Conveying and Transporting Liquids—**

# The Garfield Ejector

Cannot be beat for raising water from deep wells, mines or pits, filling or emptying tanks, raising or transferring liquids, etc.

Note the straight pipe connections making it desirable for elevating water from deep driven or drilled wells.

**Positive in Its Work and Nothing to Get Out of Order**

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are invaluable to every ambitious engineer who sees the importance of keeping his engines running at the highest-efficiency, and pushing himself ahead.

It is correct in design, principle and construction. Its records are perfect and always reliable.

There is no Planimeter equal to the Willis in accuracy or price.

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## Keeps Bearings Cool.

If you have some bearing that gives you more or less trouble, or are experiencing any difficulties in lubricating anything, you should try

## Dixon's Flake Graphite.

While this remedy is almost infallible, it is the best practise to use a little of Dixon's Flake Graphite regularly and then friction troubles will never get a start.

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Some one of the 336 different styles and sizes of our sight-feed patterns will fill any requirement you may have. When ordering, insist on getting the genuine Detroit.

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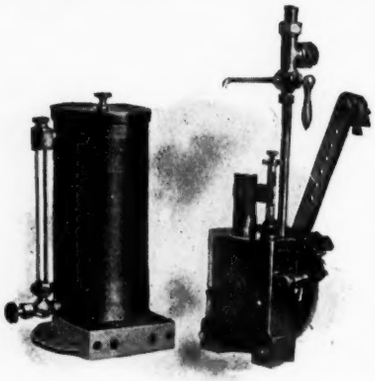
You don't have to take off your Lubricator if it needs cleaning or repairing, that is, if you have a latest improved

# ROCHESTER
## Automatic Lubricator



All you have to do is to disconnect the piping and remove two bolts and the complete works are separated from the reservoir. Send for a catalog.

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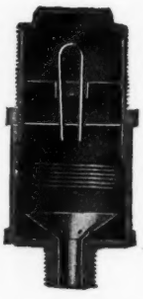

Automatic application of grease to the bearing without the use of spring compression. : : : :

**Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : : :**

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

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THREADS IN BOTH NUT AND JAW ARE ROUNDED THUS PREVENTING STRIPPING

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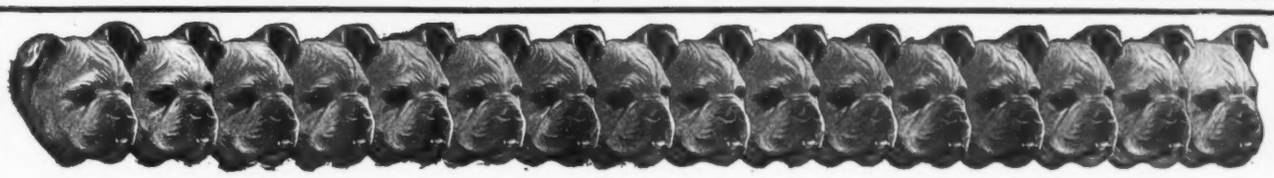
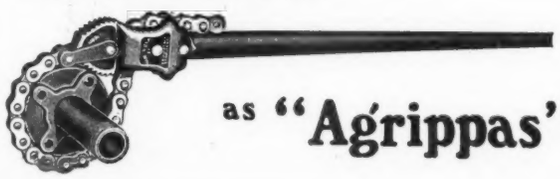


## As insistent



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as we may seem on question of Chain Pipe Wrenches, we believe the course O. K. Every job has its kinks and irregular, close or cramped fittings, too cramped for other tools with two jaws. Agrippas have one jaw, all the strength and "get there" on any kind of work. Agrippas are practically two tools in one because of utility. Discount and free trial from your dealer.

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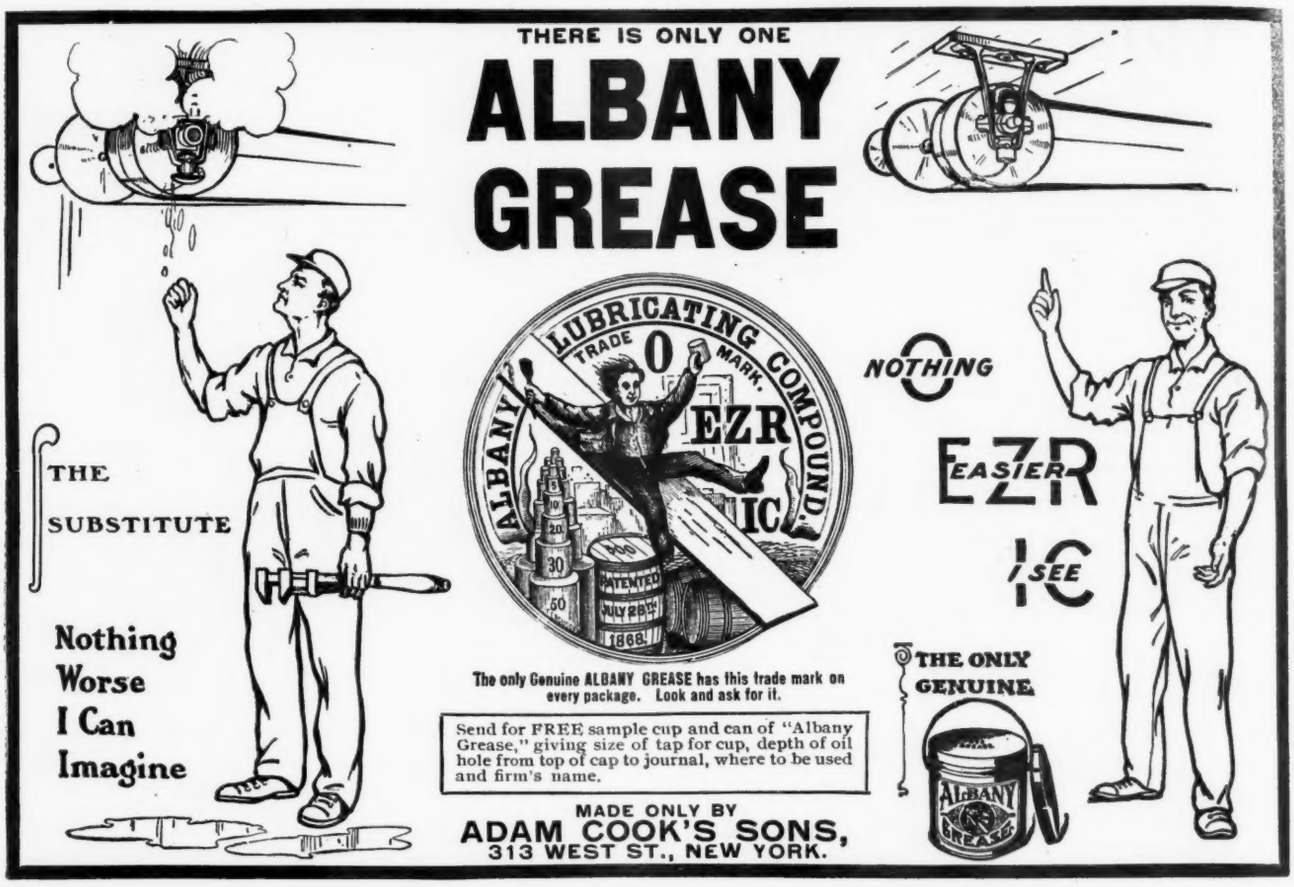
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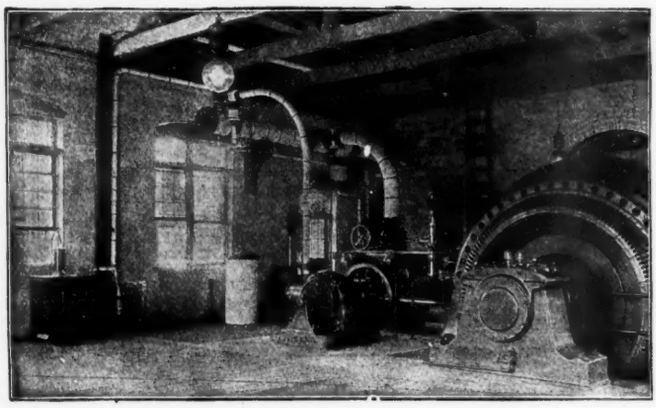
## Engine Oiling In The Modern Power Plant



Down in what most people regard as the wildest part of south central West Virginia, in the territory from which some of our finest smokeless fuels are secured, is the McKell Coal & Coke Co., Glen Jean, W. Va., operating collieries scattered at convenient points over a tract of several thousand acres. Electric power for operating these numerous scattered mines is supplied by an alternating current system of distribution from a central power plant. High-tension alternating current is transmitted from the central station to scattered substations, where it is transformed and converted into low-tension continuous current for use at the adjacent mines.

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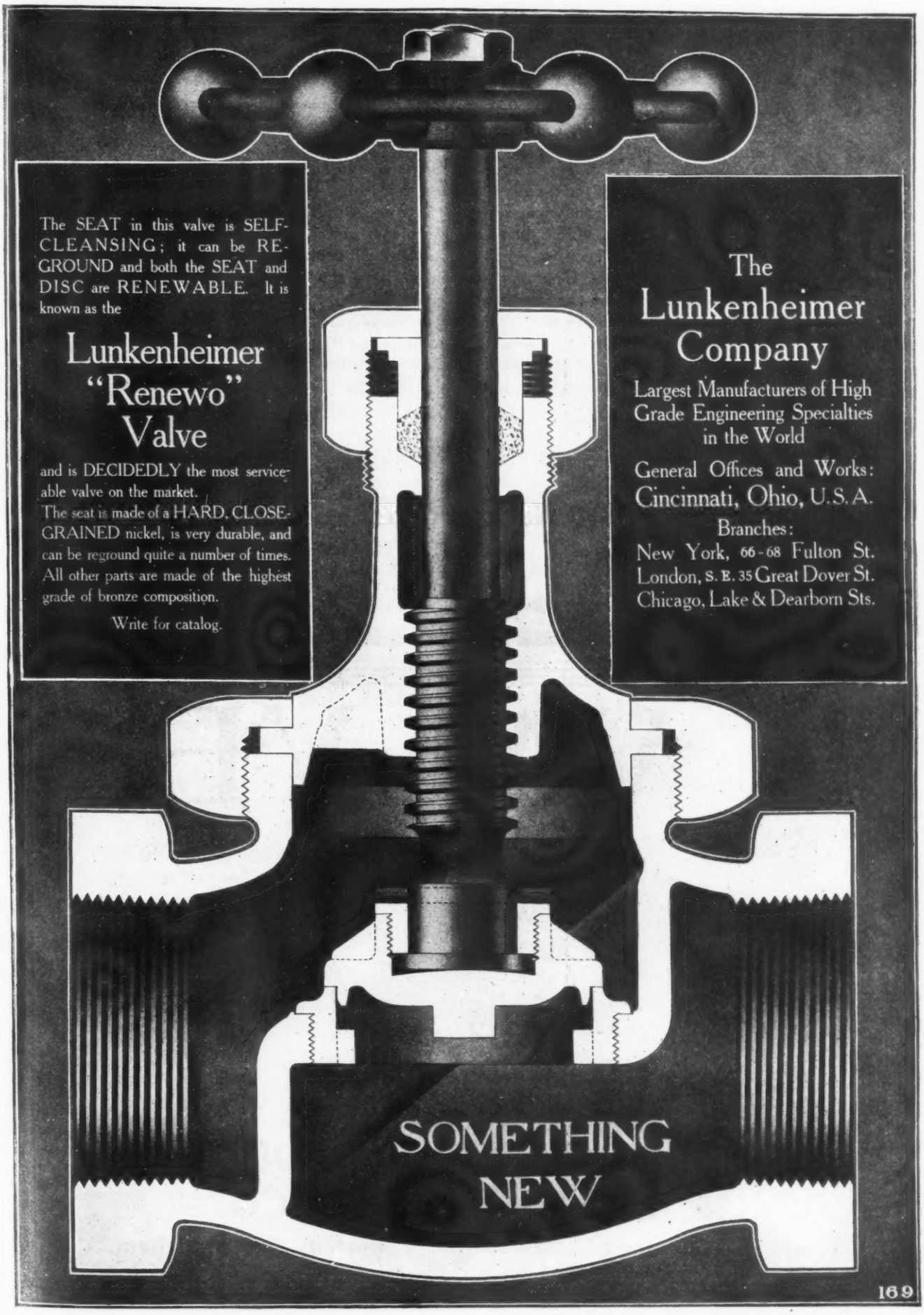
By use of the White Star continuous oiling system the bearings are all supplied with a copious flood of oil, affording that generous supply which is known to be necessary to perfect lubrication, yet *absolutely without waste*, since not a drop of oil can escape from the system, except as it is actually worn out in the bearings.

We are prepared to equip power plants of any size contracting to furnish the necessary apparatus or erecting such outfits complete. Our catalog "D" treats fully on this subject. Send for it.

**Pittsburgh Gage & Supply Co., Pittsburgh, Pa.**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The seat is made of a HARD, CLOSE-GRAINED nickel, is very durable, and can be reground quite a number of times. All other parts are made of the highest grade of bronze composition.
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SOMETHING NEW
169

DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

# Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

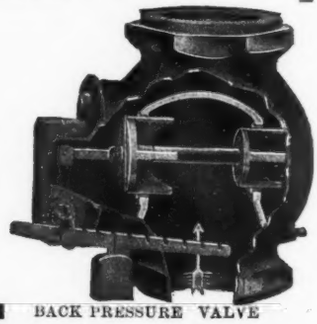
This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat ?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.



BACK PRESSURE VALVE

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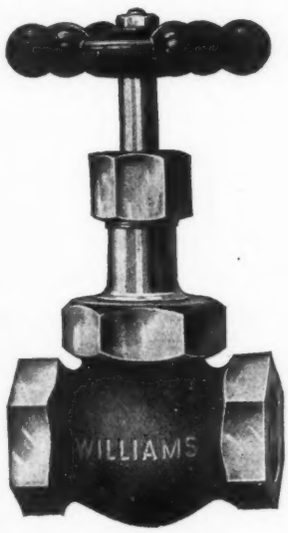


the good and bad points of all valves will invariably use a WILLIAMS, because experience has taught him that it is the most reliable and economical valve for his steam plant.

It is heavy in construction, can be repacked under pressure, and is easily reground when necessary without any extra expense. Guaranteed for 200 lbs. working pressure, the WILLIAMS is seen at its best where all other valves fail.

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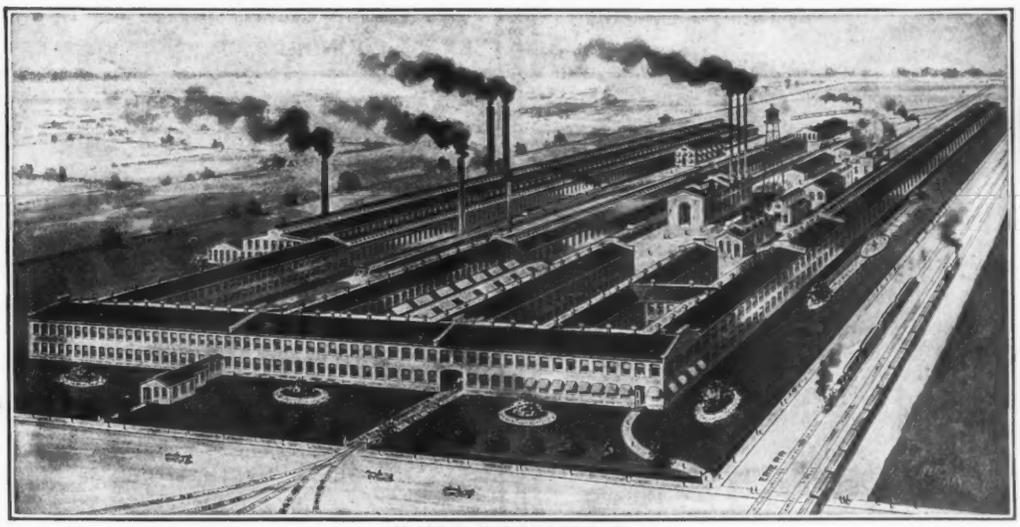
# PITTSBURGH IRON BODY GATE VALVES

ALWAYS SPECIFY **P** VALVES AND FITTINGS.

have been thoroughly tested under the most severe conditions known and have proved that they work under all pressures with less wear on the faces of the discs and seats than any other valves made.



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They are made standard for 150 lbs. and extra heavy for 250 lbs. working pressures. They can be furnished screwed, flanged or hub end; with by-pass, spur or bevel gearing and are suitable for steam, gas or water. They are made with outside screw and yoke or non-rising spindles. We have many thousands of them in use in all parts of the country and have never had a complaint or a valve returned.

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And the tempered tool steel cutters do the rest. By "the rest" we mean truing up valve seats, saving steam and power, and eliminating unnecessary work resulting from leaking, dripping valves.

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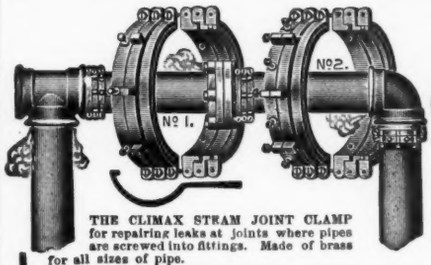
TOLEDO, OHIO.

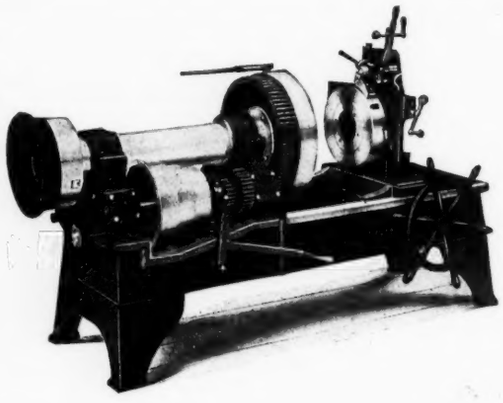



THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

## PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of
STEAM SPECIALTIES
**JAMES McCREA & CO.,**
MANUFACTURERS,
**61 West Washington Street, Chicago.**



## Peerless No. 4 Improved Pipe Threading and Cutting Off Machine

There must be some good reason for so many duplicate orders. You'll know the reason, if you are a user of our machines. They are built for rapid and economical production and will stand the racket for years.

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**BIGNALL & KEELER MFG. CO.,**
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## Unlike Globe and Gate Valves

The Homestead Valve seat is absolutely protected from wear as the pressure passes through it.

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## You Know the Value of a Uniform Pressure

The Mason Reducing Valve by a simple turn of the key secures the desired pressure and maintains it as long as you like. Get our catalog.

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A Superior NON-POISONOUS Jointing Material of Metallic Composition; for FLANGE and SCREW-JOINTS of every description on Steam, Water, Air, Gas, Ammonia, etc. UNITES TWO METALS AS ONE. Cheaper, more efficient than red lead—no waste in its use.

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Manufacturers of the Erwood Straightway Swing Gate Valve. Many valuable features in one valve. Write for Catalog.

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is the only thing that makes a gage worth having. The Ashton is accurate beyond all others. Write.

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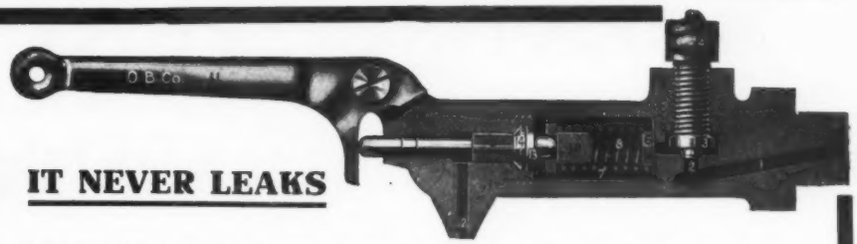
NEW YORK St. John's House, London, Eng. CHICAGO

# COLLIN GAUGE COCK

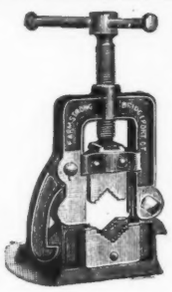


**IT NEVER LEAKS**

IS ABSOLUTELY TIGHT UNDER ANY PRESSURE. In closing, the piston "13" enters the cylinder, cutting down the velocity of the fluid through the seat "14" and preventing steam-cutting as the valve closes. A slight movement of the lever reduces velocity of discharge and prevents flashing. Made of high grade steam bronze and with or without packless, non-sticking shut-off valve.

WRITE TO-DAY FOR CATALOGUE No. P-F, describing all our steam specialties, including Water Gauges, Gate Valves and Heavy Bronze Fittings also CATALOGUE P-B describing Collin Steam Pressure Regulating Valves.

**THE OHIO BRASS CO., MANSFIELD, OHIO.** CHICAGO OFFICE 277 DEARBORN ST.



## Hinged Pipe Vises

Made in 4 Sizes

Ranging from 0 to 6 inches

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Manufactured by

**The Armstrong Mfg. Co.**

Bridgeport, Conn.

287 Knowlton, St.

This Mark Means the Genuine

## The Forbes Patent Die Stock

Simple in construction
Fewer moving parts
No unnecessary changes
Requires less power

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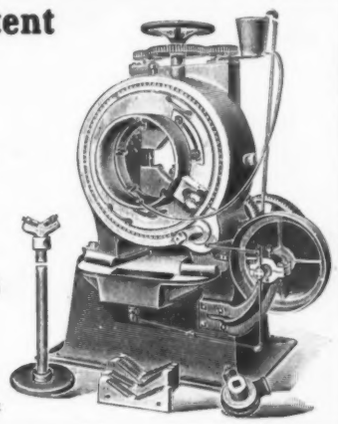

## When You Pick up a

# BEAVER

## It's Ready for Use on Any Size Pipe—Without Changing Dies. One Man Cuts ANY Size

No 0—Cuts ¼ to ¾" without changing dies or bushings.

BEAVER DIE STOCKS ARE MADE IN ALL SIZES. Each size cuts the four sizes within its range without changing dies, adjustable, and capable of cutting nipples and crooked threads.

CONSIDER THE CONVENIENCE AND ECONOMY of Die Stocks which save the time of changing dies, no loose parts to get lost or misplaced—and one man can cut ANY size thread.

*SOLD ON 10 DAYS' TRIAL BY ALL JOBBERS.*

*WRITE US TODAY FOR PARTICULARS.*

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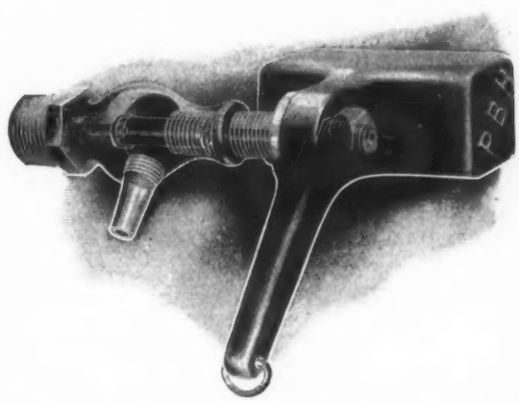
DEPT. F.

# GET ONE FREE

Put it on your boiler and give it a good trial for a month. If it gives you absolute satisfaction, keep it, and pay for it; otherwise, send it back at our expense.

**THE P. B. H. WEIGHT GAUGE COCKS**

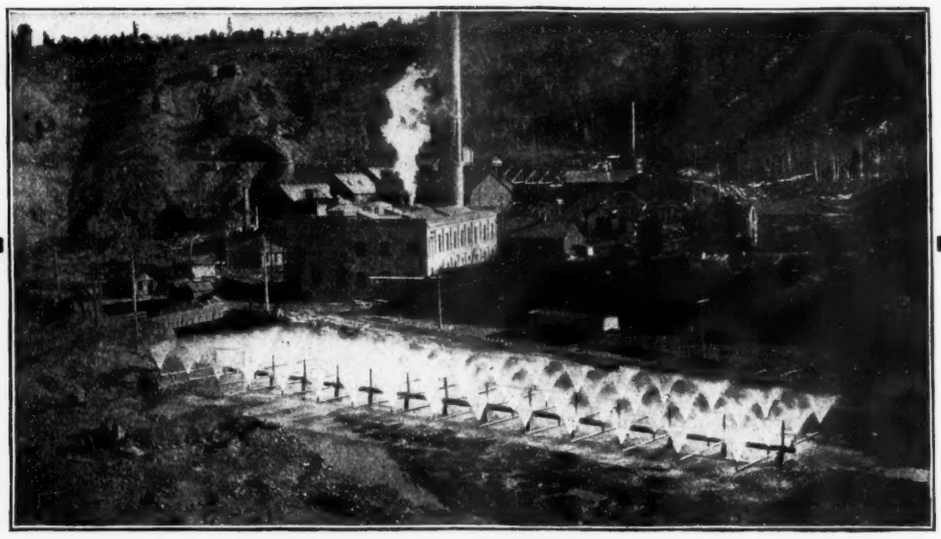


There is but one renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minute's time. Thousands in use. Absolute satisfaction on high pressure.

**THE PAUL B. HUYETTE COMPANY, INC.**
2025 BETZ BUILDING, PHILADELPHIA

# KOERTING SPRAY NOZZLES

# RE-COOLING CONDENSING WATER



PLANT INSTALLED AT DEADWOOD, S. D.

One of the most important uses of spray nozzles is the re-cooling of condensing water, as frequently the available water supply for condenser is insufficient and the necessity then arises to use the whole or part of the limited supply over and over again.

To prepare the hot water discharged from condenser for efficient re-use, it must be cooled.

Our Spray Cooling Plants are installed throughout the country, the above cut showing plant installed for the Consolidated Power & Light Co., Deadwood, S. D.

Our plants are a success wherever installed, cooling the water to within several degrees of surrounding atmosphere. Following we enumerate several concerns who have installed our system:

| | |
|---|---|
| PHILADELPHIA RAPID TRANSIT CO., | Philadelphia, Pa. |
| (32nd & Dauphin; Ogontz & Wyoming Power Plants.) | |
| DELTA SPINNING MILLS, | Frankford, Philadelphia, Pa. |
| MACON ELECTRIC CO., | Macon, Ga. |
| CAMBRIA STEEL CO., | Johnstown, Pa. |
| EVANSVILLE GAS & EL. CO., | Evansville, Ind. |
| ARMOUR & CO., | Fort Worth, Texas. |
| CARNEGIE STEEL CO., | Pittsburg, Pa. |

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## SCHUTTE & KOERTING CO.

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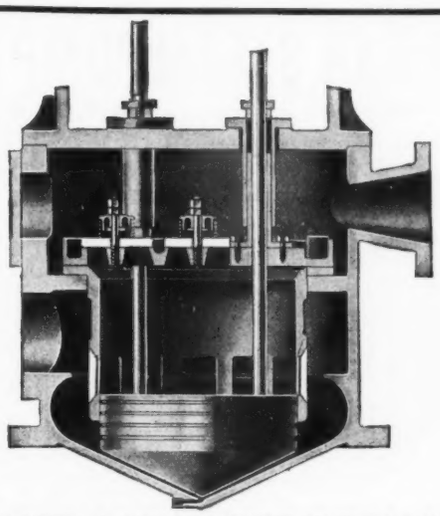

## 1 PUMP AND 1 SET OF VALVES BETTER THAN 2 PUMPS AND 5 SETS OF VALVES

THE WHEELER-EDWARDS SUCTION-VALVELESS AIR PUMP does the work of a separate condensation pump and of a rotative dry vacuum pump, while rendering unnecessary the air cooler and the jacket circulation pump usually used with a dry air pump. It gives as good, or better, vacuum than does this complicated combination of apparatus.

It can do this because of its peculiar method of operation and the fact that it has only one set of valves, which is a practical advantage besides.

The WHEELER-EDWARDS pump contains head valves only. At the beginning of each stroke the pump barrel is in perfectly free communication with the condenser. The air flows in freely, in fact is assisted in by the aspirating action of the injected water. This is in great contrast to the ordinary air pump, where the water and the valves tend to lock the air out and require pressure in the condenser to overcome them.

The WHEELER-EDWARDS pump is much more easily kept in order. In fact, it is less liable to wear or derangement than is the ordinary wet vacuum pumps, for it has only one set of valves, as against three in the latter. Even this one set can be inspected while the pump is running.

It is well known that bucket valves wear out sooner than others because of the speed and reversal of the bucket, but the WHEELER-EDWARDS has no bucket valves. Its head valves are not subject to severe usage, as the piston, by reason of the fly-wheel, "dwells" for a moment at the end of each stroke. There is none of the jerky motion of direct-acting pumps.

IF YOU ARE INTERESTED IN AIR PUMPS WE WOULD BE PLEASED TO SEND YOU OUR TREATISE "4 P," WHICH NOT ONLY DESCRIBES THIS PUMP, BUT CONTAINS VALUABLE INFORMATION AND TABLES ABOUT VACUUM APPARATUS IN GENERAL.

**WHEELER CONDENSER AND ENGINEERING CO.**
**CARTERET, N. J.**

# We're Going to Raise Your Salary

**"Yes, young man, we find that the training you have applied to your work has been so beneficial to the Company that we are going to encourage your further efforts by raising your salary."**

Such scenes as these are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If **you** are poorly paid and have ambition, there is a practical and definite system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men that adopted it.

You won't have to leave home; there'll be no interruption in your work; there's no age limit; you won't have to buy books; it makes no difference what you do or where you live; lack of capital is no barrier; it makes no difference how scant your spare time may be.

If you are ambitious, mark and mail this coupon **NOW** and find out the most practical way to raise your salary.

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**Box 979, Scranton, Pa.**

Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

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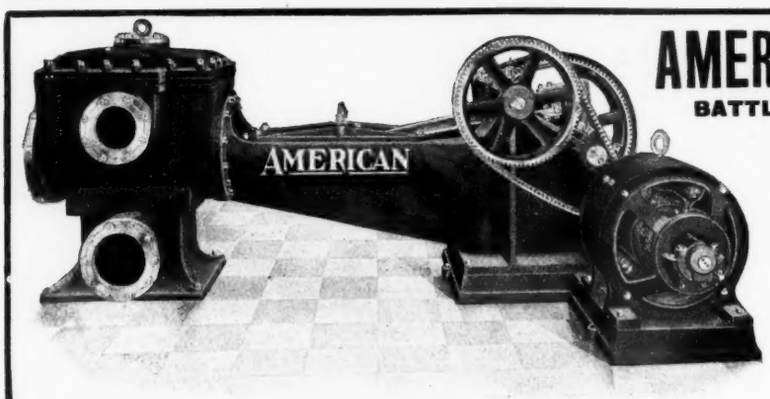
|---|---|---|
| Electrical Engineer | Machine Designer | Sanitary Engineer |
| Elec.-Lighting Supt. | Mechanical Draft. | Architect |
| Elec.-Railway Supt. | Foreman Machinist | Architectural Draft. |
| Electrician | Foreman Toolmaker | Ad Writer |
| Telephone Engineer | Foreman Molder | Window Dresser |
| Civil Engineer | Foreman Blacksmith | Chemist |
| Bridge Engineer | Marine Engineer | Sheet-Metal Draft. |
| Mechanical Engineer | Hydraulic Engineer | Ornamental Design. |
| Stationary Engineer | Municipal Engineer | Textile Designer |
| Gas Engineer | R. R. Construc. Eng | Bookkeeping |
| Refrigeration Eng. | Surveyor | Stenographer |
| Traction Engineer | Mining Engineer | Civil Service Exams. |

*Name* _____

*St. and No.* _____

*City* _____ *State* _____




American Electric Driven Vacuum Pump. Silent Chain Drive.

# AMERICAN STEAM PUMP CO.

**BATTLE CREEK, MICH., U. S. A.**

Manufacturers of
MARSH and AMERICAN STEAM and
POWER PUMPING MACHINERY
for Every Service.

We make a specialty of VACUUM PUMPS, both STEAM and POWER, for heating systems.

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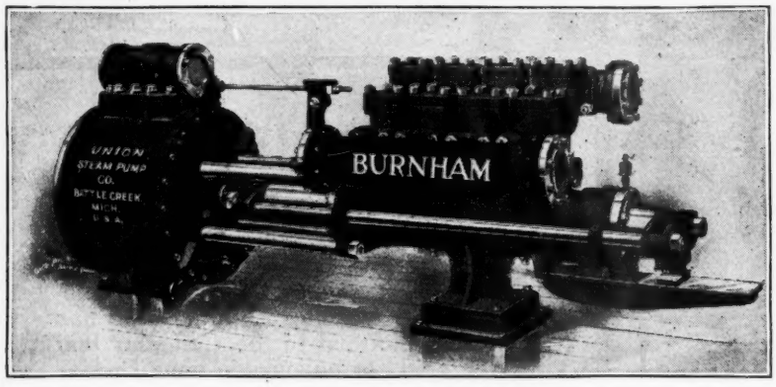
To be simple is to be great.

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**WILL NOT SHORT-STROKE**

Steam, belt and motor-driven
to meet every requirement.

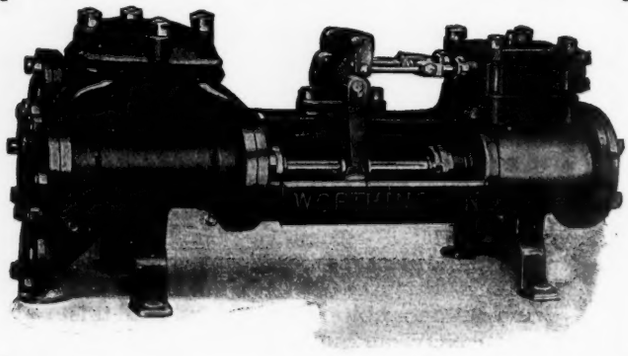
**Buy a "Burnham" and Save Money**

**Made by the**

**UNION STEAM PUMP CO.**

**Battle Creek, Mich.**

# Boiler Feed Pumps



If the Name of

# WORTHINGTON

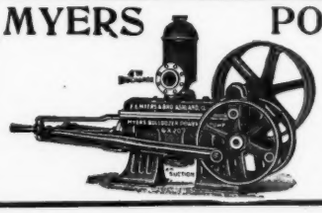
is on Your Pump it Means

**BEST** WORKMANSHIP
MATERIAL
DESIGN
SATISFACTION

**Write for Bulletin W. 117.**

**HENRY R. WORTHINGTON**
**115 Broadway, NEW YORK.**

# MYERS POWER PUMPS



Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.
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**Ashland, Ohio, U. S. A.**

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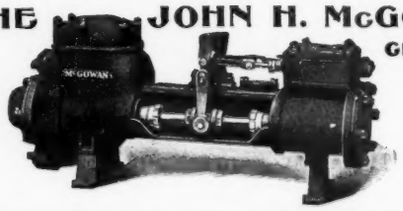

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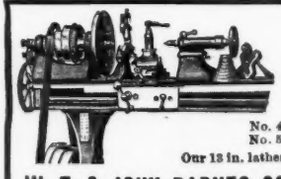
*PUMPING MACHINERY*
*Single Duplex and Fly-Wheel Types*
*Water Works Pumping Engines*



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W. F. AND J. C.

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No. 4½ Lathe, 9 in. x 25 in., List $ 75.00
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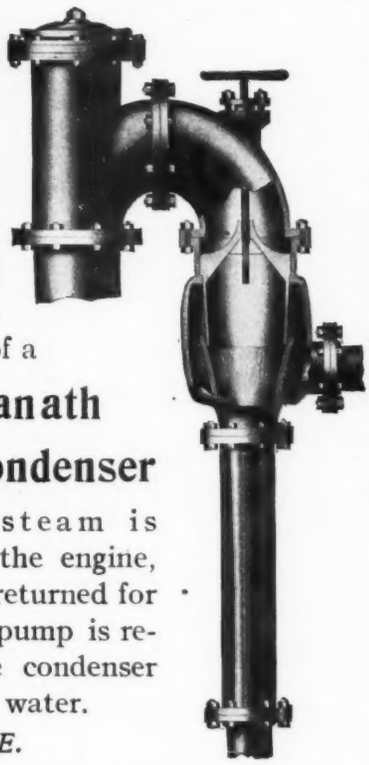
# Dean Bros. Steam Pump Works

**INDIANAPOLIS**

Simple Plunger Pump

Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

## Pumping Without A Pump



By force of a vacuum created in the contracted throat of a

**Baragwanath Siphon Condenser**

the exhaust steam is pumped from the engine, condensed and returned for re-use. No air pump is required and the condenser siphons its own water.

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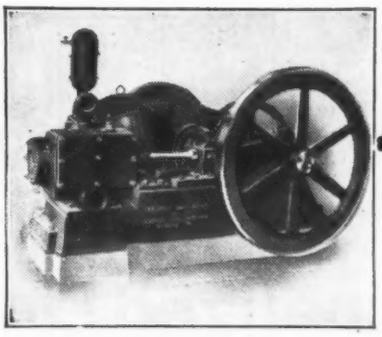
54 W. DIVISION ST., CHICAGO, ILL.
Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager.



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## DuBois Pumps

work smoothly, quietly and economically whether driven by steam, gas or motor.

All working parts fully enclosed and still readily accessible for inspection when necessary.

Capacities to 2000 gallons per minute.

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Established 1877
805 Brady Street, Dubois, Penna.

## Alberger Condenser Co.

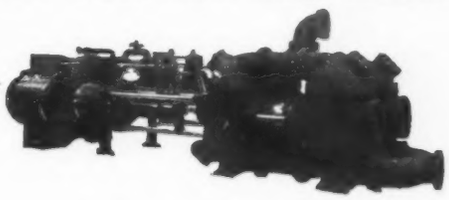
Condensers, Cooling Towers, Vacuum Pumps, Heaters

95 Liberty St. New York

Centrifugal, Volute, and Turbine Pumps

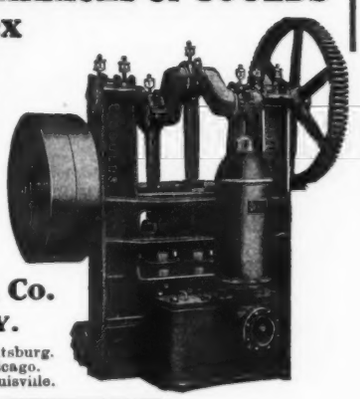
## Alberger Pump Co.

## Warren Steam Pump Co.
Warren, Mass.
PUMPS FOR ALL REQUIREMENTS.



Piston—Plunger—Hydraulic—Deep Well—Power.
Air Pumps and Jet Condensers, Combined Air and Circulating, and Marine. *Catalog.*

## The Many Installations of GOULDS Efficient Triplex Power Pumps



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Have fully demonstrated their practicability and efficiency for these important services.

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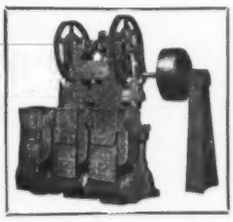
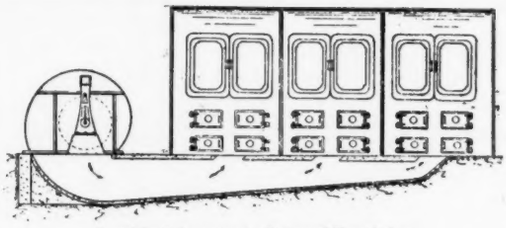
Ask for Catalogue "G" and treatise "Feeding Boilers."



For any service. **Power**

For operation by any power. **Pumps**

**The Deming Company**
Agencies in Principal Cities
Salem, Ohio



Forced Draft Apparatus for Battery of Three Boilers

# Equalized Draft

Most cheap fuels require a strong draft; their cheapness itself shows that they are unsuitable for ordinary furnaces. With any fuel, economy in cost of boilers, real estate and other expenses entering into steam production demand a high rate of combustion, which in turn requires a strong draft.

The draft obtainable from chimneys without excessive cost is strictly limited, especially where the load has increased over the capacity originally intended.

Forced draft fans combined with exhausters or chimneys have marked advantages. With exhausters or chimneys alone, the entire boiler setting is under suction, and air leaks in through cracks and crevices, and even through the mortar and brick. This air dilutes and cools the products of combustion, thereby reducing the boiler efficiency.

On the other hand, with forced draft alone, the interior of the furnace is under pressure, and there is a constant leakage of hot gases outward, heating and injuring the boiler setting and fouling the air in the boiler room.

However, where part of the draft is produced by a chimney or an exhaust fan and part by a forced draft fan, there need be no difference of pressure between the inside and outside of the furnace.

In short, equalized draft leads to high furnace efficiency, just as the Green Fuel Economizer leads to high boiler efficiency. Also like the Economizer, it permits increasing the capacity of existing plants at small cost, and with improved economy.

A forced draft arrangement in connection with a chimney is shown above, the chimney draft and forced draft each being regulated by automatic dampers. We have also installed plants with forced draft fans in connection with exhausters, the speeds being automatically regulated.

State your conditions, and we will devise suitable plans. Also ask for our special pamphlet, No. 108 P, on Mechanical Draft.

**The Green Fuel Economizer Co.,**

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New York City, Boston, Chicago, Atlanta, San Francisco,
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Engineers, Builders of Green's Fuel Economizers, Fans, Blowers, and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 162

## No More Steam Wasted

When you keep an accurate expense account you are likely to spend less money foolishly—it is the same way with steam.

This Meter is also adapted to the measurement of water, of air and other gases.

*Write.*

**G. C. ST. JOHN**
**140 Cedar St., NEW YORK**

**The St. John Indicating and Recording Steam Meter.**

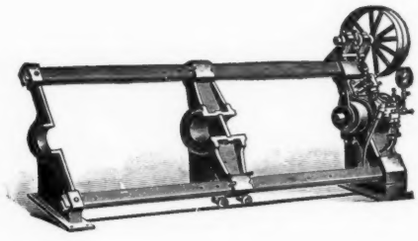
# Any Pressure

UP TO 8,000 LBS. PER SQ. INCH
can be positively and automatically controlled with the

**FISHER PUMP GOVERNOR**

For use in Hydraulic Service, Air Compressors, and all types of Pumps working under pressure. *Sold under guarantee to satisfactorily perform its work. Write if interested.*

**THE FISHER GOVERNOR CO.**
**MARSHALLTOWN, IA.**



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**Permanent Tile Forms For Reinforced Concrete**

This system of chimney construction will save, as compared with the iron stack, over $150 a year. Write.

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In use under Stationary Boilers, Locomotives, Kilns, Etc.
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**The Curtis Damper Regulator**

is the most simple, durable and economical device on the market. Regulates to any position with the varying steam pressure—no water connection. It is fully up to the standard of other Curtis products.

*IF YOU ARE NOT FAMILIAR WITH THEM WRITE FOR DESCRIPTIVE CATALOG.*

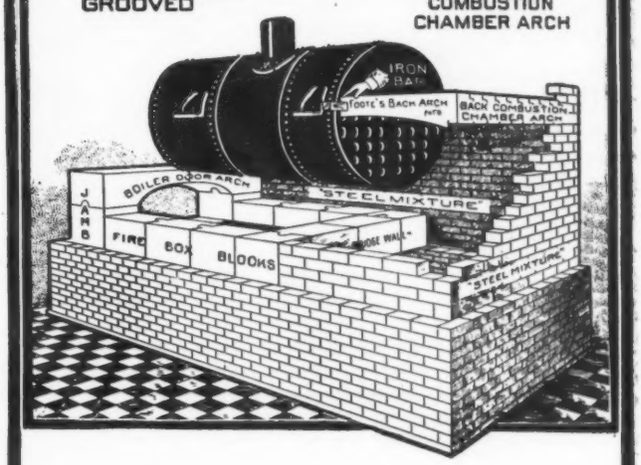
**Julian D'Este Company**
24 Canal St., Boston, Mass.

**"STEEL MIXTURE"**

**BOILER DOOR ARCHES AND FIRE BOX BLOCKS**

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH




# Boiler Door Arches

The "STEEL MIXTURE" Boiler Door Arch takes the place of the built up Jambs and iron or brick arch that is ordinarily used.

The Jambs are in one solid, smooth piece the full height of the door and flaring back from the opening.

On these, and held to them by tongue and groove, is the Arch. This is in two pieces, jointed in the centre and extending from the front to the boiler.

For convenience and durability, this construction is unexcelled. Write for particulars asking for Dimension Booklet.

MANUFACTURED BY
**McLEOD & HENRY CO.**
TROY, N.Y., U.S.A.
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

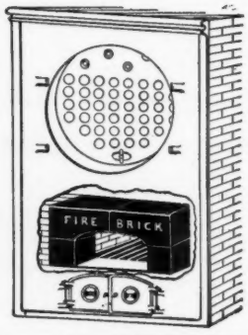
# REAGAN GRATES

The grate which carries with it a GUARANTEE to evaporate 25% more water than any other grate or stoker in the market under similar conditions or no money.

Adopted by the Boston and Northern Street Railway Co., and the Boston Elevated Railway Co., Boston, Mass.

**REAGAN GRATE BAR CO.,** 209 North Front Street, PHILADELPHIA, PA., U.S.A.

# Your Boiler Settings




require the protection of perfect fire brick Write for prices.

**Presbrey Fire Brick Works**
**Taunton, Mass.**

## From The Coal Cellar To The Sky Above The Plant
## WILKINSON'S AUTOMATIC STOKER AND SMOKE PREVENTER

makes its good influence felt and especially in the pocket that pays the coal bills.

**THE WILKINSON MFG. CO., Bridgeport, Montgomery Co., Pa.**

# "SIROCCO"
TRADE MARK

## FANS AND BLOWERS

*BUILT ON THE TURBINE PRINCIPLE*

**SIROCCO ENGINEERING CO, 138 Cedar Street, New York**

# MARTIN GRATES

Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.

**MARTIN GRATE COMPANY, 281 Dearborn Street, CHICAGO.**

# GREEN TRAVELING CHAIN GRATES

AUTOMATIC SELF CLEANING SMOKELESS

**GREEN ENGINEERING CO.**
COMMERCIAL NATIONAL BANK BLDG., CHICAGO:
ALLIS-CHALMERS CO. CHICAGO, ILL., EXCLUSIVE AGENTS FOR ALL FOREIGN COUNTRIES EXCEPT CANADA AND MEXICO
GENERAL FOUNDY WORK A SPECIALTY

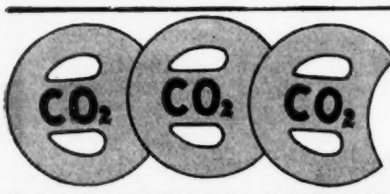
ANY TYPE OF BOILER

## The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

**MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.**

UNITS OF ANY SIZE




C-O-Two Tile

## FIRE ARCHES

Any Rise, Any Span, Air Baffle Mixing System produces

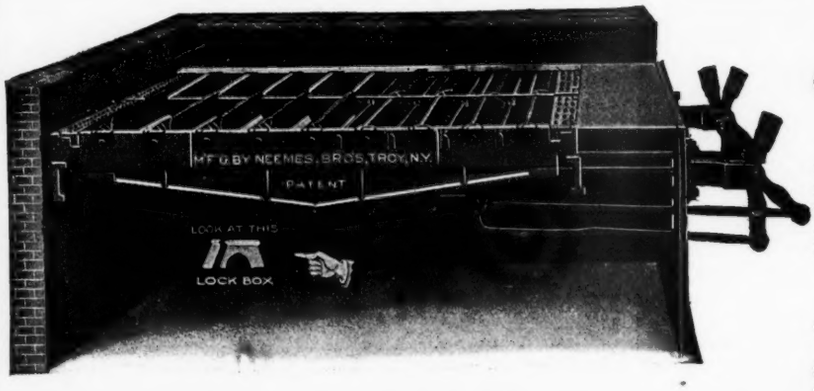
**RESULTS**

**C-O-TWO FURNACE COMPANY, Syracuse, N. Y.**

# PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

**CLIMAX SMOKE PREVENTER COMPANY**
**205 Equitable Building, Boston, Mass.**




# NEEMES BROS.

IMPROVED

## Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

**NEEMES BROS.,**
**41-49 Adams St., TROY, NEW YORK**

C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.

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**A book that should be in the hands of every engineer**

**Guaranteed! Your money back if you are not satisfied**

### It Explains and Shows

The science of electricity clearly. How the dynamo is made and the different methods of winding armatures. How to connect the dynamo to switchboard. How to care for and handle dynamos. How to connect dynamos together when running in parallel. What to do if your dynamo works badly. How to install, run, care for and handle dynamos and motors.

How to set valves on the different kinds of steam engines so as to get the best results. How to get the proper amount of compression on each end of a cylinder. How to line an engine so that it will run smoothly. How to equalize the cut-off. How to set the valves on different kinds of steam pumps. The care and handling of inspirators and injectors. Care and operation of different kinds of pumps. The care and handling of, how to indicate and set the valves, how to find horse power and how to get the proper compression on a compound condensing engine. How to line a twin tandem Corliss engine. How to line and put up shafting and how to figure out the horse power of shafting. How to figure the different kinds of gearing, and the horse power of the different kinds of gears. How to figure horse power of belts and their care. Also the driving power of belts. Rope transmission; horse power transmitted by rope.

## This Engineer

is one of 25,000 who own, believe in, and are guided and helped in their everyday work by **Tulley's Handbook.**

This is the standard work, the encylopedia, the dictionary and gospel of the steam and electrical power plant engineering profession. There's a thousand pages, every one brimful and bristling with useful, practical information. Yet, in all those thousand pages you can't find anything foggy; no algebra; no Latin nor Greek; no 'isms nor 'ologies—nothing but what is plain, clear, understandable and *useful*. Tulley's Handbook is a friend, a counsellor, a right-hand helper to every engineer and those who would be. Read the list of contents herewith. Then read the guarantee. Then send us your order. You'll never regret it.

*GUARANTEE*—Send $3.50, the price of the book postpaid. We'll mail at once. If you are not satisfied in *every* particular, return the book in good condition within five days of receipt and your money will be refunded at once.

## Hill Publishing Co.

**505 Pearl Street, New York**

*Power* *American Machinist*

*The Engineering and Mining Journal*

### It Explains and Shows

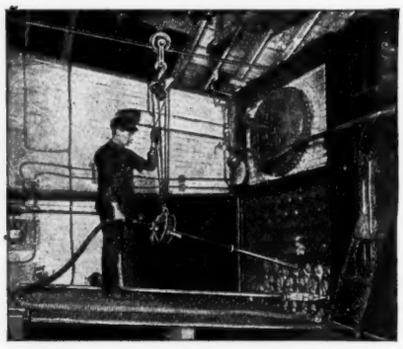
The principles of ice-making and mechanical refrigeration. How to handle, repair and operate an ice or refrigeration plant. How to test for water by evaporation. Effects of ammonia on pipes. Lubrication of refrigerating machinery. How to charge the system with ammonia.

How to calculate the horse power of tubular or flue boilers. How to calculate the proper sized boiler to furnish steam for a steam pipe. How to figure out the safe working pressure for boilers. How to figure the number of stay bolts required for a certain pressure, according to U. S. R. and H. S. B. I. Co. Safe working pressure that may be carried on boilers according to U. S. rules. How to figure the capacity of air compressors, also the amount of air required by pneumatic tools. How water is pumped by air.

How to care for and handle electric and hydraulic elevators. How to figure the safe load for hoisting cables and how to care for them.

A great many tables are given covering all sorts of steam and electrical matters, so that immediate reference can be made and an answer found without figuring.

Over twenty pages are devoted to questions, with the answers, that are usually asked an engineer when applying for a license.



## "In Bad Scale, or with Tubes Chuck Full, the Weinland Mechanical Cleaner is THE Machine."

We recently shipped a Weinland Mechanical Cleaner to Mr. J. L. Ziegler, Chief Engineer, MERCHANTS ICE & COLD STORAGE CO., Los Angeles, Cal., and after cleaning his Geary boiler in record time, he wrote us that he would take the machine. Since then, he has ordered another Weinland for cleaning his condenser tubes.

How thick was the scale and how long did it take to clean tubes the last time you cleaned your boilers?

If scale does not accumulate in your tubes very rapidly, but the boiler has not been cleaned out for some time, it would pay you to have the tubes first cleaned out thoroughly with a Weinland Mechanical Cleaner and thereafter to use the **WEINLAND WING HEAD TURBINE,** which is unexcelled for medium and light scale.

Never cut out tubes simply because they are full of scale. A WEINLAND MECHANICAL CLEANER will bore them out and a WEINLAND WING HEAD TURBINE will keep them clean at small expense.

We sell and rent machines, and clean boilers by contract.

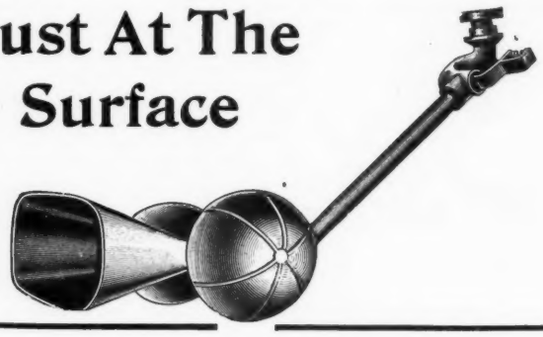
Write for treatise, "Boiler Scale and Its Removal," also booklet describing our new Direct Driven Steam and Air Motor Cleaner as shown in the above picture.

**The Lagonda Mfg. Co.,**

**Springfield, Ohio.**

New York Philadelphia Pittsburg Chicago San Francisco
Birmingham Toledo London

## Just At The Surface



### The Buckeye Boiler Skimmer

floats—rising and falling with the water level and continually drawing off the scale-forming impurities before they have a chance to deposit in the tubes.

Think of saving barrel after barrel of chemicals and being relieved of all scale trouble.

**Buckeye Boiler Skimmer Co.**

**South End, Toledo, Ohio.**

## BIRD-ARCHER BOILER COMPOUNDS

BIRD-ARCHER COMPOUNDS are the best possible boiler protection because they are made up specially for each case and recommended only after careful feed water analysis by experienced specialists.

If you have used BIRD-ARCHER COMPOUNDS you know that they are always good and reliable. You know that they are exactly adapted to their work and have virtues not found in other compounds.

Don't risk your boilers and make trouble for yourself by trying some inferior substitute.

Write for our book, "Ten Questions for Steam Boiler Users."

**The Bird-Archer Co.,**

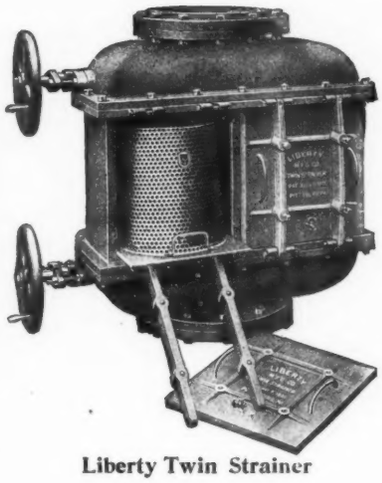
**90 West Street, New York City.**

# The One Sure Way to Promotion and Pay

**(Use Liberty Expense Reducers)**

What's the use of a strainer that works all right for nine days and lets the pipes get choked with foreign matter on the tenth, while it is being cleaned? The Liberty Twin Strainer works continuously year in and year out—one side straining while the other is being cleaned.

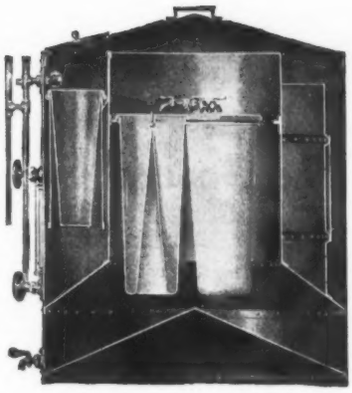
Heavy Duty Turbine Cleaner



Liberty Twin Strainer

Liberty Turbine Cleaners require just half as long to thoroughly clean your boiler tubes as cleaners of any other make.

They never injure a tube and will remove scale of any thickness.



Liberty Oil Purifier

Turbine Cleaner For Light Scale

There's mighty little oil wasted after a Liberty Oil Purifier is installed in the plant.

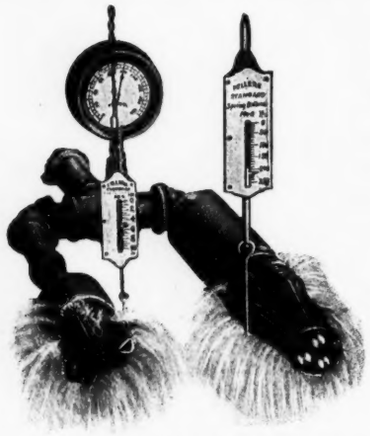
The Liberty differs from other oil cleansing devices in that it refines the oil instead of simply straining it. No water, bone dust or charcoal used.

**Send for the "Liberty" Catalogs**

## Liberty Manufacturing Co.

**6509 Susquehanna St., Pittsburg, Pa.**

# The Pull of the "Demon"



The 'Demon' on the right of photo showing over 40 times the pulling power of the turbine. Pump pressure 100 lbs. Reproduction of actual test.

It takes a mighty strong twisting force, torque or pull to clean water tubes rapidly and perfectly.

There never was a self-contained water-driven cleaner that could even approach the "DEMON" for power.

Where does the "DEMON" obtain its immense power? Here's an illustration. Press your thumb over the outlet of an open water faucet and see how soon the accumulating pressure of the water forces an opening. *This is the principle of the "DEMON."*

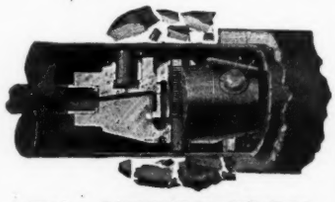
After trying the above hold your thumb a half inch or so below the opening of the faucet and you discover the pressure is slight in comparison with the previous experiment. *That is the principle employed in every turbine cleaner.*

The "DEMON" uses every ounce of pressure directly upon rotary pistons. The water *must* rotate the pistons (and the cutter head) before it can escape. With a 3" piston area and 100 lbs. water pressure it means 300 lbs. pull which reduced to practice causes a rapid crushing of all scale as it is caught under the steel roller cutters. Send for free trial proposition and don't fail to read our folder No. 54 "Demon Cleaners vs. Other Cleaners," or No. 56 on "DEMON" curved tube cleaner.

The "TORPEDO" holds the undisputed lead in the fire tube cleaner class.

Just to show you that this cleaner can save you money—lots of it and it is the best and safest cleaner you ever saw, let us send you one on free trial. If you are satisfied it will pay you 200% or more on the investment buy it, if not send it back.

Our circular No. 30 gives some interesting facts on cleaners. Want one?



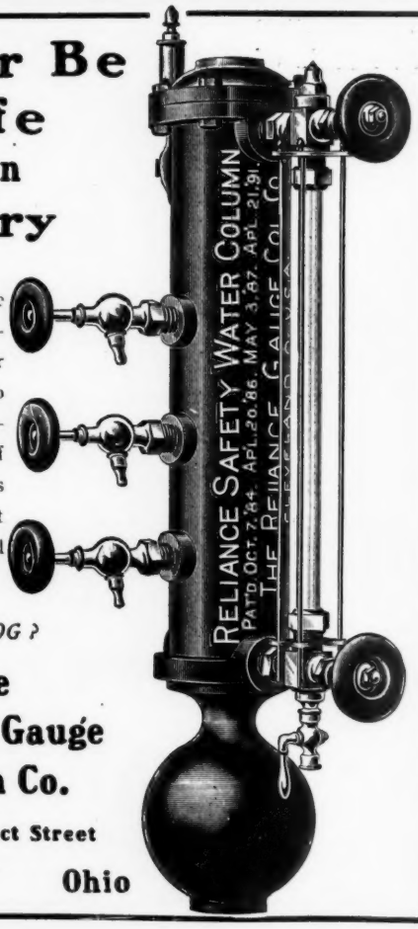
**The "TORPEDO"**

THE "TORPEDO"

Removes all scale from tubes of fire tube boilers.
Saves 11 per cent of fuel for each 1 16 inch of scale.
Prolongs life of tubes.
Saves compound.
Centers itse f in tube.
Strikes same in every direction.
Stroke limited and cushioned.
Does not hammer but vibrates the tube.
Is absolutely safe and easily operated.
Has but one moving part.
Will last a lifetime.

**The General Specialty Co., 887 Niagara Street, Buffalo, New York.**

# Better Be Safe Than Sorry



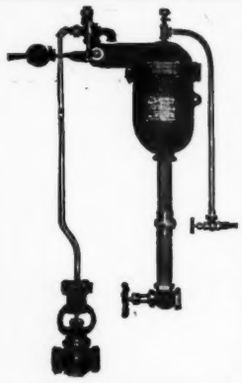

Will you be the next to place reliance in this water column? 55,000 engineers are trusting the safety of their plants to its efficiency and it has never failed one.

*CATALOG?*

**The Reliance Gauge Column Co.**

**75 E. Prospect Street**

**Cleveland, Ohio**



# The Vigilant Feed-Water Regulator

for steam boilers was the first in the *field*, and has the longest and best record of any of these devices.

**Costs Less to Operate and Maintain**

Constructed on a different and better principle than any other.

Investigate it and the

**FULTON PUMP GOVERNOR**

and send for latest catalogue with list of users.

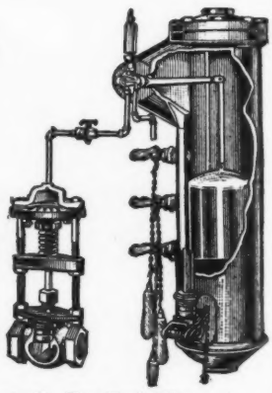
A guarantee from a responsible firm with every machine.

**THE CHAPLIN-FULTON MFG. CO.**

J. S. Ward, Agt., 7 9 S. Jefferson St. Chicago.

**Pittsburg, Pa.**

# THE BERRY Safety Automatic Feed Water REGULATOR



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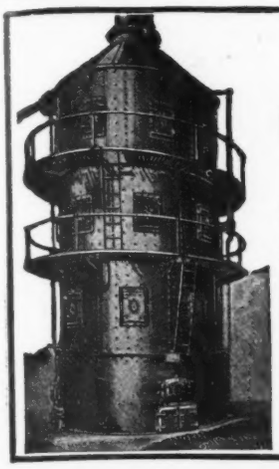
**BERRY ENGINEERING COMPANY**

**Chester, Penn.**

Metropolitan Office, 136 Liberty St., New York City.



**When You Buy Get the**

# CLIMAX BOILER

Compact—generates great power in small space. Safe—no large surfaces exposed to steam pressure Economical—generates more steam per pound of coal than any other boiler. Sizes from 50 to 1,000 h. p. You should have our booklet. Get it.

**The Morrin Climax Boiler Co.**

Main Office: 240 Lorraine St., Works: Smith Lorraine, Court and Creamer Sts.
Telephone 243 Hamilton
**Brooklyn, N. Y.**

LOCAL SALES OFFICES:

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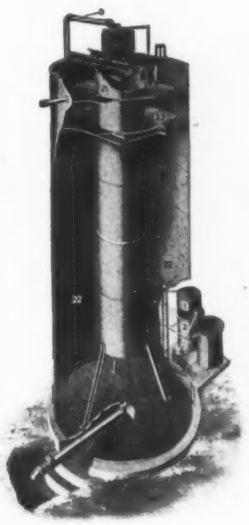
**A PROPERLY SOFTENED WATER WILL SAVE**

# Fuel, Repairs, Compound Bills

AND DOUBLE THE LIFE OF A BOILER



Such a WATER can be automatically obtained by the use of a

**BARTLETT WATER SOFTENER**

no matter how hard the water is originally. Write.

Manufactured by
**Northern Water Softener Company,**
**Madison, Wis.**

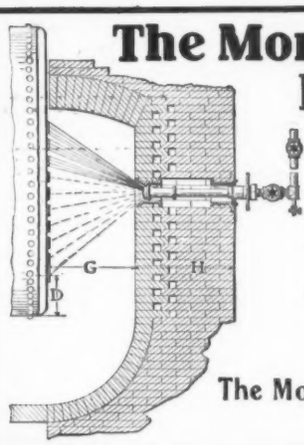
# HEINE BOILERS

**(Water Tube)**

**All flange steel construction.**
**Shipped from the shop completed.**

BUILT ONLY BY THE

**Heine Safety Boiler Co.**
**ST. LOUIS, MO.**

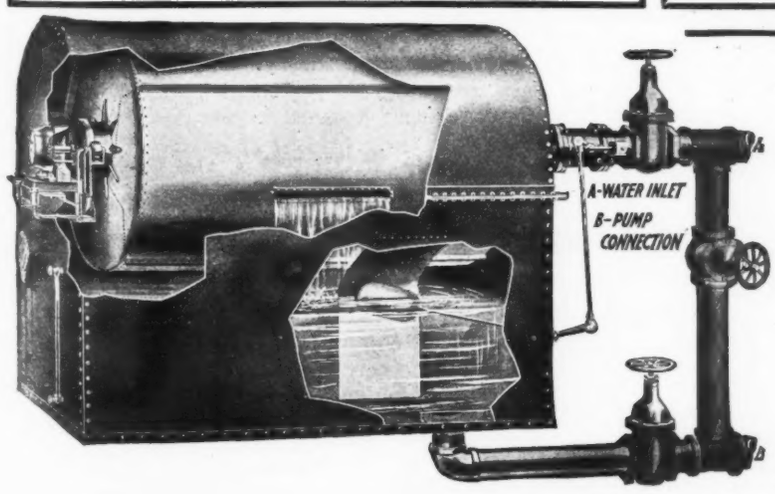



# The Monarch Steam Flue Blower

keeps boiler tubes absolutely clean by blowing the soot in the direction of the natural draft, to the front of boiler and out through the chimney. All the tubes are cleaned in 5 minutes with no loss of time, steam pressure or fuel. This is the only correct device made for the purpose.

*CIRCULAR?*

**The Monarch Steam Blower Co.**
Troy, New York




# What Are Your Boilers Doing?

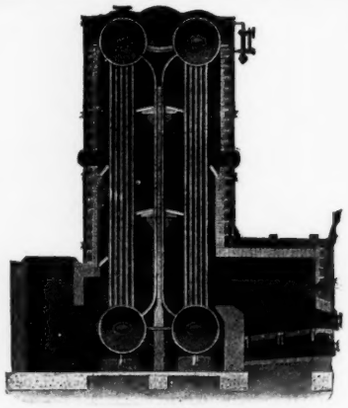
Are you getting the best economy?
Is your coal best fitted for your purpose?
**Can You Tell Your Evaporation?**
A

# DETROIT METER

**Will Give You a Continuous Record of Your Boiler Feed Water**

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

**CENTRAL STATION STEAM COMPANY**
**Detroit, Mich., U. S. A.**
*SEND FOR CATALOG.*



TYPE B

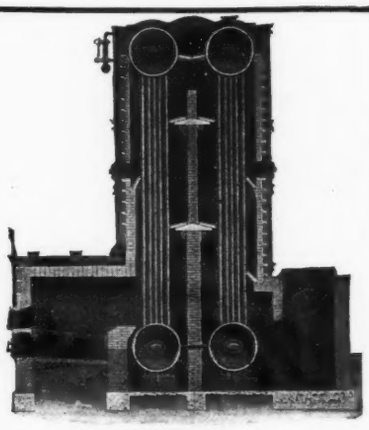
# THE RUST
## WATER TUBE
# BOILER

SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

Write for Report of Tests by William Kent.

**THE RUST BOILER CO.,**
PITTSBURGH, PENNA.

THE RUST ENGINEERING CO., Birmingham, Ala.
Southern Agents | New Orleans, La.



TYPE C

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**PARKER BOILER CO.**
WATER TUBE BOILERS—SUPERHEATERS.
**PHILADELPHIA, PENNA.**
New York—Pittsburg—Chicago—Denver—San Francisco.

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**Foster Superheaters**
Insure uniform stroke of direct acting pumps.
**POWER SPECIALTY CO.,**
111 BROADWAY, NEW YORK.

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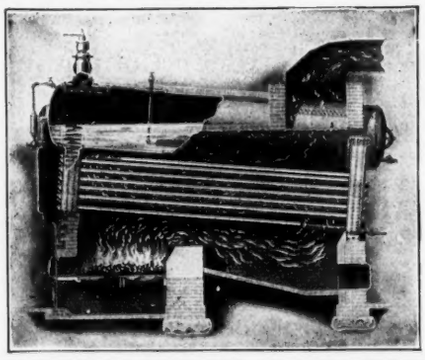
**FRANKLIN WATER TUBE BOILER**



BUILT BY
**FRANKLIN BOILER WORKS CO.,**
**TROY, N.Y.**
SALES OFFICE
39 Cortlandt St.;
New York, N. Y.

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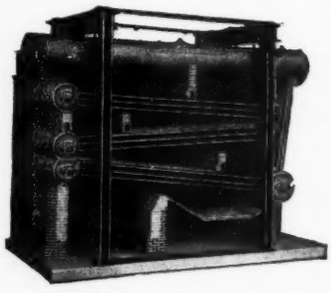
**STEADY WATER LEVEL**



rapid circulation, accessibility for cleaning and inspection and the largest heating surface make Vogt Boilers superlatively efficient.

*Write.*

**Henry Vogt Machine Co., Inc., Louisville, Ky.**

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**Morison Suspension Furnaces**
**For Land and Marine Boilers**
also—FOX CORRUGATED FURNACES.

Uniform Thickness
Easily Cleaned
Unexcelled for Strength

*Manufactured By*
**The Continental Iron Works**
Near 10th and 23d Ferries,
West and Calyer Streets.
**Brooklyn, N. Y.**

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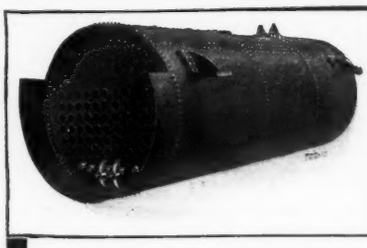

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**Are Boilers of CHARACTER**

They bear the mark of superiority. They are built by mechanics, are strong, solid, substantial, efficient, durable. Have the name KEWANEE in your specifications.

**KEWANEE BOILER COMPANY**
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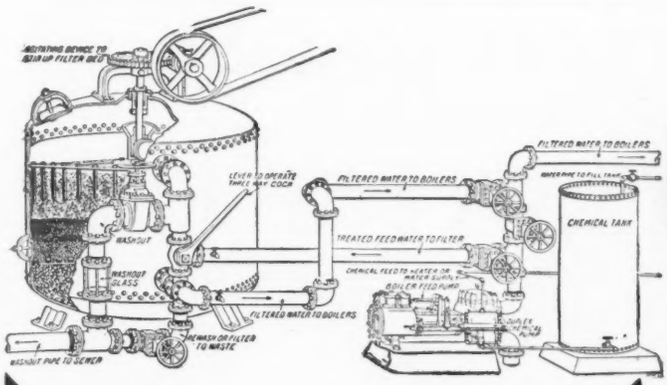
# Edge Moor Boilers
—WATER TUBE—
**EDGE MOOR IRON CO., Edge Moor, Delaware**

*No Contraction of Area at Drum Connection.*

*Send for Catalog S.*




# THE KEYSTONE
## Pressure Filter System

is sold under this positive guarantee:

That it will remove all vegetable and mineral impurities from any water.

That boilers using feed water so treated will remain free from foaming, scale or corrosion.

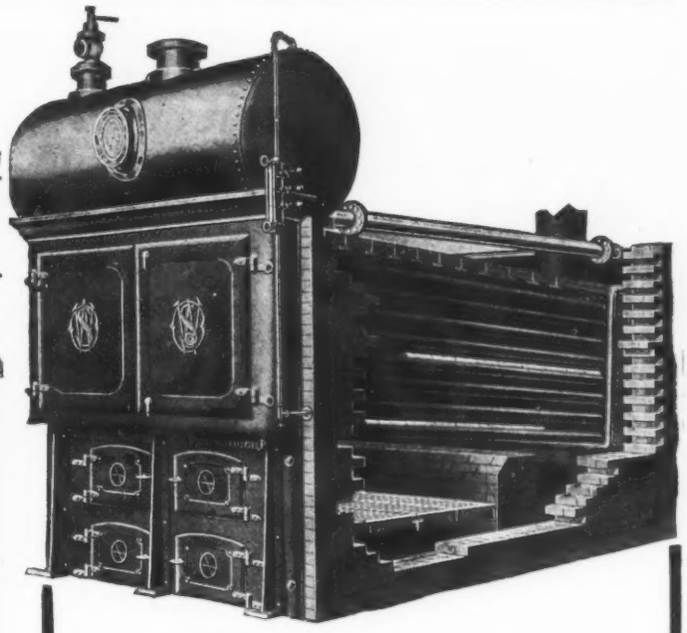
That if the KEYSTONE PRESSURE FILTER SYSTEM fails to fulfill these conditions it will be removed without cost to the customer.

OPERATION.

The diagram above shows a complete installation. Observe its compactness, and the absence of settling tanks or other cumbersome accessories. Its operation is absolutely positive. Nothing is left to chance. The water to be purified is subjected to careful chemical analysis; its dissolved impurities determined and a chemical agent provided that will precipitate itself and the dissolved impurities together, as insoluble matter. In this form it is filtered out together with the suspended impurities, leaving a pure, harmless water to enter the boilers.

Complete information supplied on request.

**The Keystone Chemical Mfg. Co.**
**Philadelphia Chicago San Francisco**



# The Basis Of Economy

in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

# Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

*Ask for illustrated catalog and latest test report.*

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**Boiler Works Dep't., - - OSWEGO, N. Y.**

**Branch Offices—NEW YORK, PHILADELPHIA.**

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**STEAM SUPERHEATERS—MECHANICAL STOKERS**

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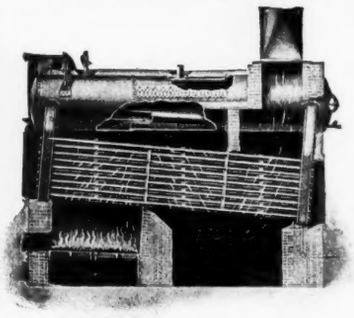
## Water Tube Boilers



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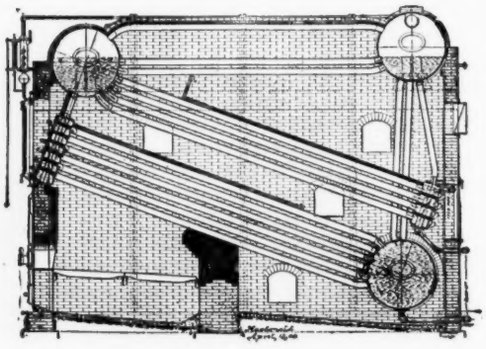
We manufacture all machinery and parts needed to equip a complete Ice or Refrigerating plant—

**Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.**

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.

## Robb-Mumford Water Tube Boiler



Free expansion of tubes—Perfect water circulation—Dry or superheated Steam—Half the usual number of handholes.

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Built in Canada by Robb Engineering Co., Ltd., Amherst, N. S.

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That absolute knowledge that your ice machine is producing full capacity at the minimum expense; that there is no danger of shut downs for repairs—this is the result of using Triumph machinery.

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**In addition to our unequaled compressor construction, remember we also provide you**

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## INDUCTION
# MOTORS

HIGH EFFICIENCY
HIGH POWER FACTOR
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1 TO 75 H. P.

10 H.P., 220 V., 3 H. P., 1200 R.P.M.

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from Type A Transformers demonstrates their superior qualities.

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Their construction embodies correct proportion of copper loss to core loss for average Central Station load and a distinctive arrangement of iron, copper and insulation in the transformer to obtain the most economical operation.

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Well adapted for Driving Pumps, Ventilating Fans in Shafts or Flues, Large Drill Presses, etc. The compactness of **C & C Motors** is due to the use of Steel Magnets of the highest grade, and perfect armature ventilation.

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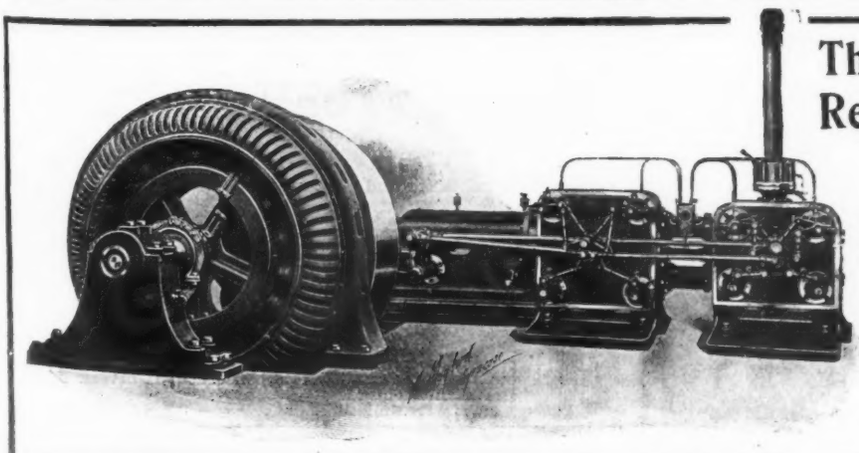

## This Engine Runs 200 Revolutions per Minute

High speeds; high pressures; unsurpassed economy; low repairs; the most perfect valve motion; low cost per engine horse power; still lower generator cost. The first Corliss engine we ever built run 26 years at the rate of 11 hours per day. It is still absolutely perfect and is the engine we show prospective buyers. Better investigate our engine records.

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Our type of BLOWING ENGINES for Blast Furnaces and Bessemer Steel Works is largely used in the United States and Europe.

Built of vertical and horizontal pattern; simple and compound steam ends; and air cylinders fitted with our patented grid-iron valves which make it possible to operate at higher speeds than with the usual form of air valve.

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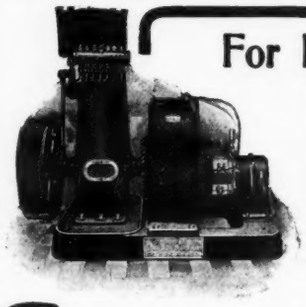

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This compact machine is the best known means of illumination.

In operation it is steady, safe and clean, but its principal advantage lies in low cost of operation and extreme durability.

Requires very little attention and furnishes a better light cheaper than you can buy it from the mains.

Write for full details.

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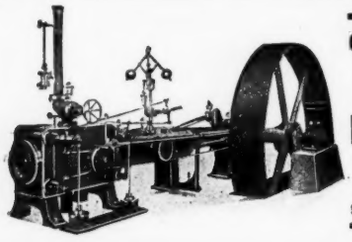

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**Refrigerating and Ice Making Machinery**

**THE VILTER MFG. CO.**

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Engines have been tried and found true—let us tell you more about them.

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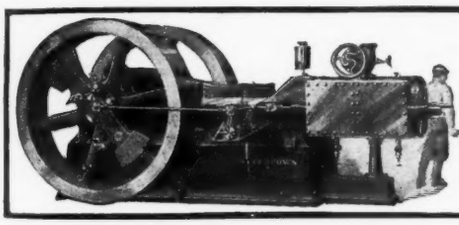

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**We Manufacture**

**AN ECONOMICAL AND DURABLE ROTARY ENGINE**

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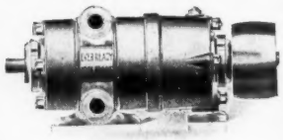

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## "EXPENSIVE"

Only in the same sense that Government bonds are.

When you buy a

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you pay a slight premium for the assurance of future economy, efficiency and reliability. CATALOG ?

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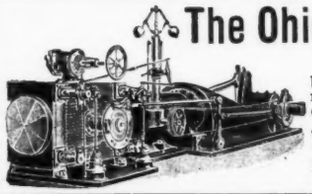
## The Ohio Corliss Engine



For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.

**THE GRIFFITH & WEDGE CO.**

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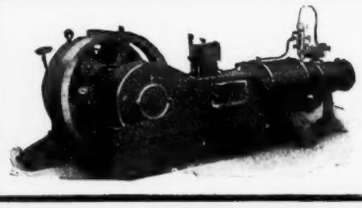

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ACCURATE REGULATION FOR ELECTRIC SERVICE—AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR

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Power plant auxiliaries require trustworthy power. Northern Motors meet this requirement exactly. You can always rely on your pumps, conveyors, blowers, etc., as far as the power is concerned, if driven by Northern Machines.

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**BUILDERS OF HIGH CLASS**

# STEAM AND GAS ENGINES

**HIGH IN DUTY, SUPERIOR IN REGULATION**

**AND**

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**CORRESPOND WITH US BEFORE PURCHASING**

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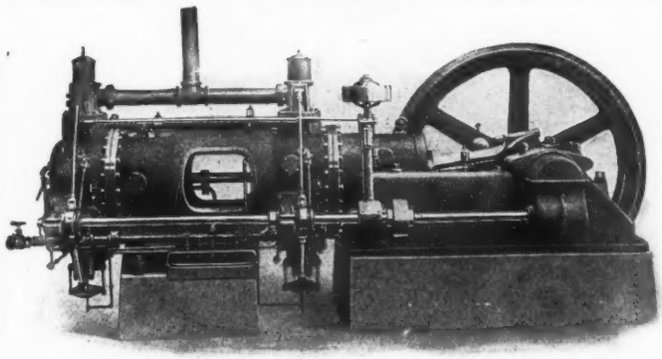

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Types up to 700 H. P.

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Economy and Reliability Have Been Demonstrated by Actual Service

**FULLY GUARANTEED**

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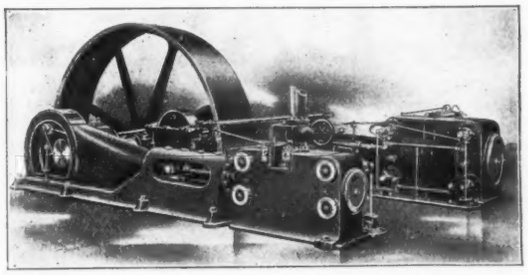

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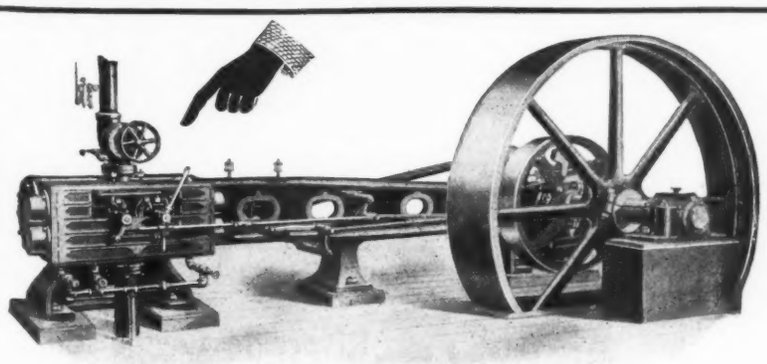
Silent Running—
Noise means waste energy.

# PROVIDENCE ENGINEERING WORKS,

**New York Office, 42 Broadway.** **Main Office and Works, Providence, R. I.**



# One Hour Per Year, Mr. Engineer,

will keep this engine steam tight for a quarter century. The time you save will easily pay for the engine.

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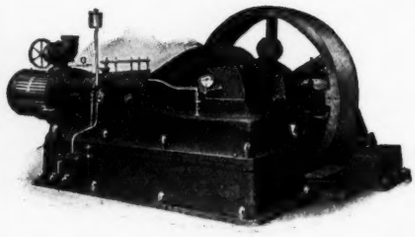

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SIDE CRANK
SINGLE and FOUR VALVE

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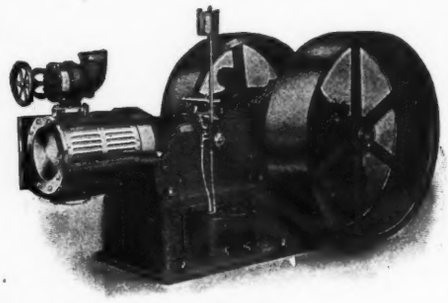

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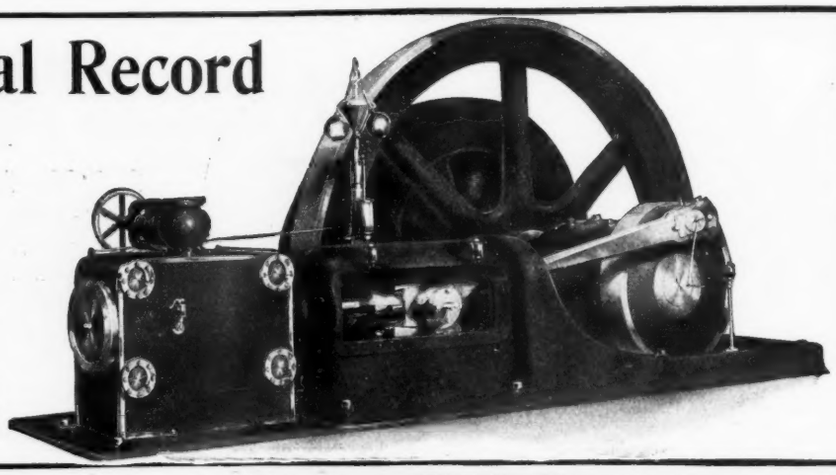
for economy, reliability and high efficiency has been made by the **Cooper Corliss Engine** in electric lighting, railway, rolling mill and general power plant service.



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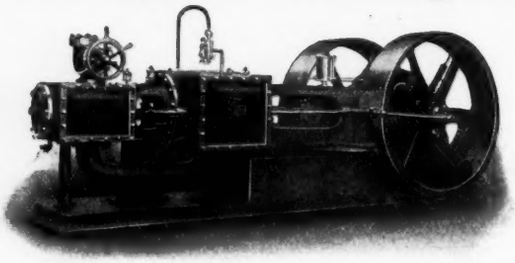
# The McEwen Engine



**RIDGWAY DYNAMO & ENGINE CO.,**
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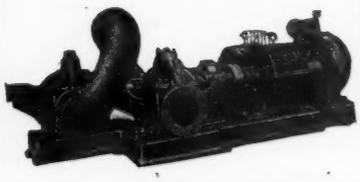

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De Laval Turbine-Driven Series Pump. *Send for Catalog No. 20.*

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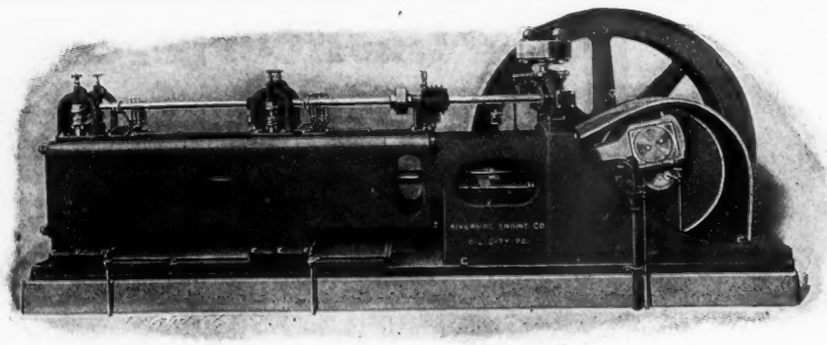

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Engines are the standard American Gas Engine. They have the reliability of a steam engine, the greatest accessibility, are extremely simple and are economical to operate.

Built in all types, single cylinder, single acting to twin tandem double acting, 40 to 2,500 H. P.

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Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C)

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INCORPORATED

CHESTER, PENNSYLVANIA

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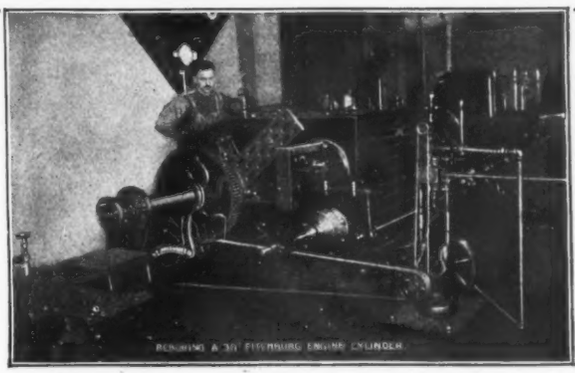
BERRY SAFETY **BOILERS** POWER PLANTS



**On the one hand**

You can dismantle your engine, ship away the parts, wait a week or more, get them back, reset, and start work again—if the bill don't break you—or

*Write for "Hints to Engineers."*



**On the other hand**

We will send men and portable tools, do the work in one night and you start up next morning as usual without loss of one work-day hour. We'll save money for you.

*Ammonia Cylinders indicated.*

**H. B. Underwood & Co.,** Estab. 1870 **1021 Hamilton St., Phila., Pa.**



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| 20 x 42 Allis, Corliss | 16 x 32 Buckeye, Automatic |
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Also large assortment of Automatic and Throttling Engines of other sizes.

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84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

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WE MAKE A SPECIALTY OF

Corliss Engine Repairs. Engines Indicated.
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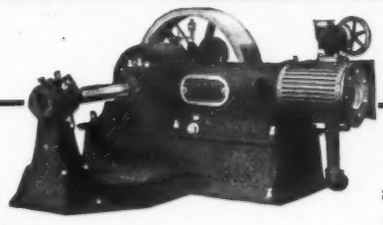
# "ERIECO" ENGINES



**SELF OILED**

from a trough in the oil-tight frame, the lubricant is forced to all bearings, without churning, but in such quantities as to absolutely prevent undue heating of any part.

**AUTOMATIC**

and absolutely reliable by reason of a governor so constructed that the engine will neither race when the load is taken off, nor slacken speed when the load is increased.

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## Rotary Converters

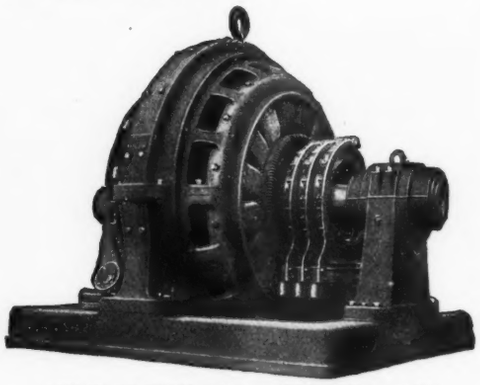
**For Light and Power Service**

**The Synchronous Regulator**

is a feature found only in Westinghouse Rotaries; it results in

**High Efficiency,**
**Perfect Regulation**
**Minimum Floor Space**

**Ask nearest office for particulars**

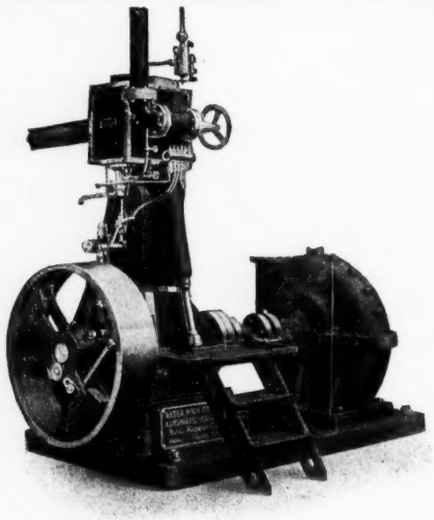


1000-K. W. Westinghouse Rotary Converter with Synchronous Regulator.

**Westinghouse Electric & Mfg. Co.**

Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, St. Louis, Salt Lake City, San Francisco, Seattle, Syracuse

Canada: Canadian Westinghouse Co. Ltd, Hamilton, Ontario. Mexico: G. & O. Braniff & Co., City of Mexico.



Bates Vertical Automatic High Speed Engine for connection to Pumps. Especially adapted for

**WATER WORKS, IRRIGATION**

and other places where it is desired to move a large volume of water at small expense.

*CATALOG FOR THE ASKING.*

**BATES MACHINE CO., Joliet, Ill.**

# YOURS

## ON A MINUTE'S NOTICE

*We have for immediate delivery:*

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h.p.; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are **new** engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

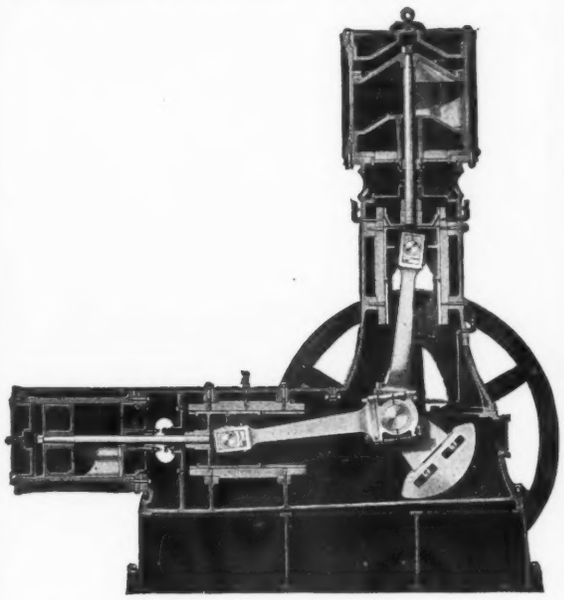
**Get busy** and communicate with us.

**C. H. BROWN ENGINE CO., Inc.**

**FITCHBURG, MASS.**

Chicago Representative—FRANK H. POND & Co., Fisher Bldg.

# A PERFECT COMPOUND ENGINE



Engineers have long sought a type of compound engine which could be substituted for the simple automatic engine for driving electric light generators and simple work. The possible steam economy of 25% or so to be gained by compounding seemed to make the quest worth while. However, most of the compound engines proposed for this work have hitherto had shortcomings which overbalanced, at least in part, the advantage of smaller steam consumption.

Tandem compounds occupy too much room and require large foundations. There are no advantages in the way of more even turning moment or better balancing.

Cross compounds meet with the same objections, but in a more aggravated form, as to expense for foundations and space; further the weight and cost of base castings is practically doubled. Cross compounds are no easier to balance than are simple engines.

The ideal solution of the problem has been arrived at, however, in the AMERICAN BALL ANGLE COMPOUND ENGINE. The floor space occupied is no larger than would be required for a simple automatic engine of the same power. Placing two cylinders at right angles permits accurate balancing in all directions. It is impossible to exactly balance the reciprocating parts in a single cylinder engine without introducing an unbalanced condition in a direction at right angles to the piston travel, but in the ANGLE COMPOUND the balancing is perfect. Two cylinders at right angles give a more even turning moment, and because of this there is less friction upon the bearings and pins and alternators driven by ANGLE COMPOUNDS will run parallel without any trouble and without use of heavy wheels.

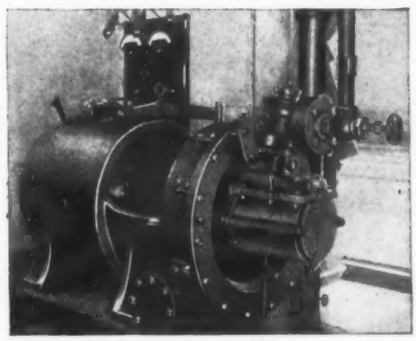
If you are in any way interested in engine performance, it will be worth your while to send for our handsomely illustrated Bulletin No. 14, explaining all details of this remarkable engine.

**AMERICAN ENGINE CO.,**

**22 Raritan Ave., Bound Brook, N. J.**



# Small Curtis Turbines are Simple and Compact.



**The Curtis Turbine Generating Unit with switchboard forms the most compact and easily operated set ever placed at the service of the small plant engineer.**

*The Small Curtis Steam Turbine Unit easily leads other types of generating apparatus in simplicity and compactness of design and construction.*

The revolving parts consist simply of a shaft, a group of turbine wheels, an armature and a governor—and that's all.

There is no flywheel, no piston, piston rod, cross head, wrist pin, connecting rod, crank, eccentric, dashpot, rocker arm or other trouble maker.

Until this Curtis Turbine Generator was developed, the vertical reciprocating steam engine set of the marine type was the most compact set in general use

## But

The turbine sets require only about half the cubical space required by vertical engines of the same capacity, and less than half the floor space of a horizontal engine.

***General Electric Company***

**Principal Office: Schenectady, N. Y.**

**New York Office: 30 Church St.**

**Sales Offices in all large cities.**

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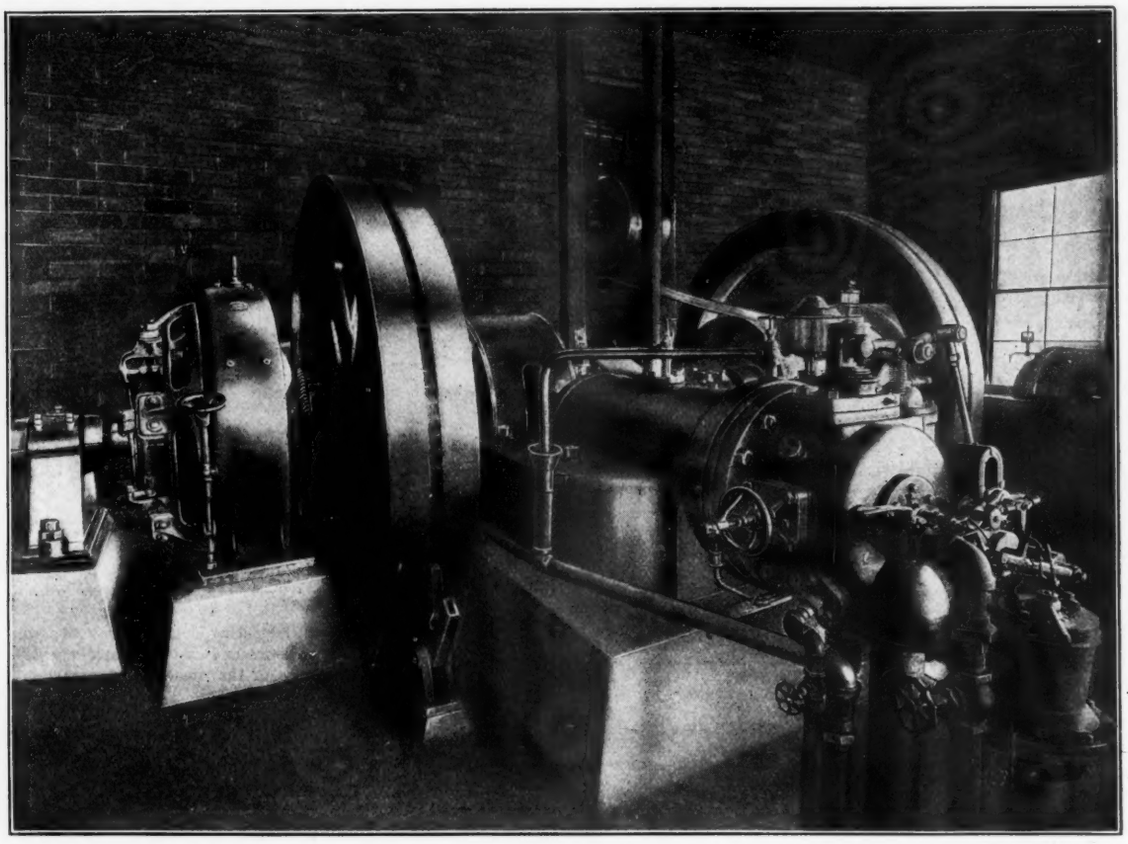


# Nuenzel Gas Engine and Suction Producer Plant

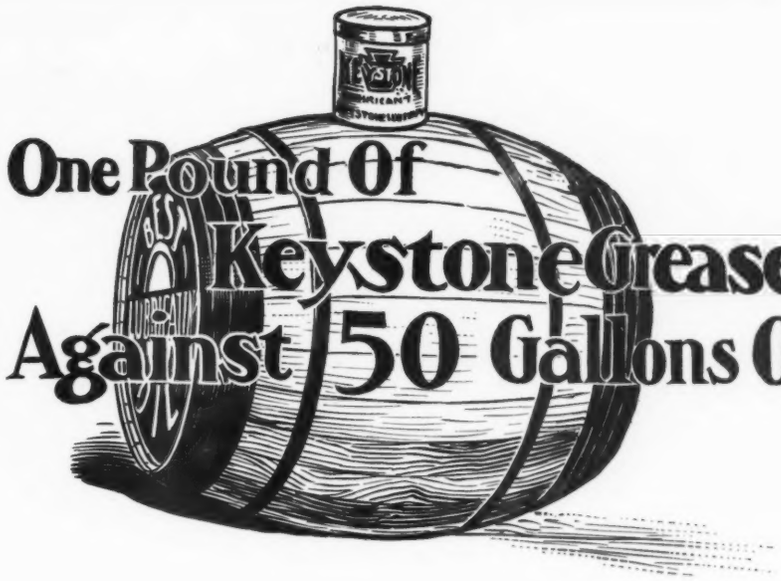
The above cut shows one of the direct connected units in the Power Plant of the M. & St. L. R'y shops—where we have four different Engines.

"This Engine ran day and night without a single stop for 92 days—when shut down for examination was in perfect condition."—*From operator's report.*

*How about reliability?*

**Minneapolis Steel and Machinery Co.,**

**Minneapolis, Minn.**




# One Pound Of Keystone Grease Against 50 Gallons Of Oil

That's the proportion between the two for an equal amount of work—and "Keystone" will require but one fiftieth as much attention. Besides that tremendous saving, our Grease does not melt and run away, or collect dirt or grit, and it is

KEYSTONE
TRADE MARK
REGISTERED U.S. PAT. OFF.

## Not Affected By Extremes Of Heat Or Cold

All the disadvantages of oil lubrication are overcome by Keystone Grease and friction is practically eliminated by its use. Every particle of it is used and no sediment or gum remains in the bearings—this, because "Keystone" is absolutely pure and contains no harmful ingredients.

No other lubricant approaches our Grease in either efficiency or economy. It is the one you have been looking for.

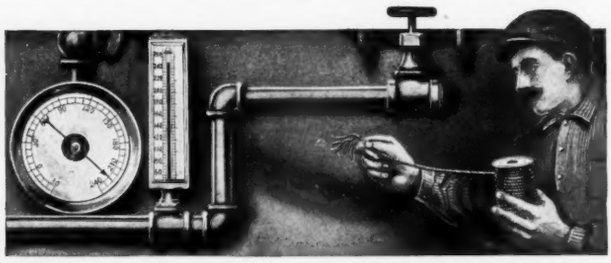
**See our Advertisement on page three.**

# Keystone Lubricating Co.,

**Department B.**

**PHILADELPHIA, PA.**

New England Office, 10 Oliver St., Boston, Mass.
Chicago Office, 1210 Tacoma Bldg.
Northwestern Office, 502 McPhee Building, Denver.
Southern Office, 610 Chartres St., New Orleans, La.
New York City Office, 96 Warren Street.
San Francisco Office and Warehouse, 268 Market Street.



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## PACKING

will please you as it does other engineers because it reduces the labor of repacking less than one-half. It is not hard to understand how this is possible when you examine the packing and find that it is made entirely of mineral substance, and that every strand carries its own lubricant.

Braided (round and square) for large valves.
Twist ($^1/_8$", $^3/_{16}$" and $^1/_4$" on 1 lb. spools) for small valves.
Send for FREE working samples and be convinced.

**GREENE, TWEED & CO.,**
**Sole Manufacturers.**
109 Duane St., NEW YORK.

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SPECIALISTS IN
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FOR
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## SPEED INDICATORS
**OR REVOLUTION COUNTERS**

**No. 104.**—This indicator may be run at the highest speed required without heating. The working parts are encased. Dial has two rows of figures, reading right or left as the shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The (0) mark may be instantly set at starting point.

**Price, Postpaid, $1.00**

**No. 107.**—Has all the good points of the above, and in addition has a hard rubber handle for insulation when used on electrical machinery. It also automatically registers the number of revolutions up to 5,000, thus relieving the mind from keeping count.

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